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ABSTRACT

In contrast to language-teaching systems which stress conversation, this system for teaching Arabic starts by presenting the written language. One reason for doing so is that knowing how to write Arabic characters helps students to remember the unfamiliar sounds of this language. A computer-assisted instruction (CAI) program was felt to be more efficient and rapid than either conventional teaching or programed instruction because it allows for individual instruction and immediate feedback. To cover the objectives of this course, the CAI program is divided into four cycles, each of which presents seven letters and a few diacritics. This report describes the lessons, the hardware and software requirements, and the procedures employed in authoring and producing the program. Development of the course followed the instructional design model developed at the University of Texas CAI Laboratory. Tryouts of the course showed that its use prevented the usual attrition in attendance which had occurred previously because of the long time required by other methods to teach the writing system. Also the standard deviation for the CAI group was much smaller and the learning gains for slower students were greater enabling them to approach the proficiency of the best students. (JK)

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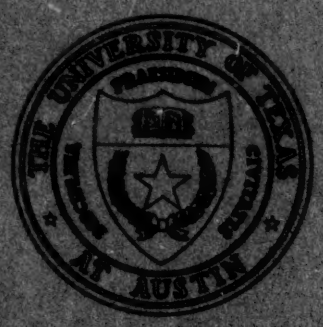
TECHNICAL REPORT NO. 4

Victorine C. Abboud and C. Victor Bunderson



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C. Victor Bunderson, Director
Austin, Texas 78712

P R E F A C E

Instructional software design for computer-based instructional systems is an infant discipline whose growth and development will have a far-reaching impact on education. It is inter-discipline whose intellectual geography lies somewhere between education disciplines (especially educational psychology), computer science, and radio-television-film. At most institutions, it does not find a comfortable base in any of these existing departments.

The impact of instructional software design on a field of knowledge and its transmission may be due to an intellectual restructuring of the goals, objectives, and organization of the knowledge space. This contribution is independent of the existence of computers (but not the information processing ideas developed in connection with computers). The impact on the efficiency and effectiveness of transmission of the knowledge space may, however, be due to the unique capabilities of a computer-assisted instruction (CAI) system. The knowledge space itself may be restructured by a computer implementation which, depending on a discovery of functional redundancy in that knowledge space, describes it compactly and conveniently as a data structure and an associated set of algorithms. If the algorithms can operate on the conveniently represented data structure to produce for the student an interaction for any desired objective than a new, much higher level of understanding of that field of knowledge has been achieved. A less dramatic contribution dependent on the computer may be achieved due to its unique capabilities of speed, flexible information processing, and dynamic information-display--plus the fact that all of these capabilities are organized and controlled into a complete system. This contribution exerts its influence on the efficiency and effectiveness of instruction, rather than on a higher, more powerful conceptualization of what is taught.

The project described in this report serves as a case study in which instructional software design provided a restructuring of goals, objectives, and organization independent of the computer, yet used unique computer capabilities to obtain very substantial increases in the efficiency and effectiveness of instruction in the Arabic writing and sound system.

An Overview of Instructional Software Design

An "instructional design model" developed at The University of Texas at Austin in the Computer-Assisted Instruction Laboratory guided the design and development of the Arabic writing program. An early version of this model was described by Bunderson (1971). It has evolved since

the time of that writing (1968) through graduate seminars on CAI program design and theory. From one perspective, it represents a set of heuristics to aid in the solution of design problems, analagous to Polya's (1957) heuristics for mathematical problem solving. From another perspective, it represents a framework for management and quality control of CAI program development projects. From still another perspective, it serves as an anchor point for research on instruction to increase the probability that such research will be relevant to the instructional designer's task (Bunderson & Dunham, 1971).

In the Bunderson (1971) paper, the instructional design model was represented as an iterative sequence of activities to be performed by the designer and the associated products of each activity. Since that writing, it has proved useful to elaborate on the products of instructional design, classifying them into three categories: public documentation, intermediate design products, and final program materials. These three categories are the headings for the three columns in Figure *i*.

In general, instructional software design has the flavor of systems engineering. That is, the context of the course to be developed in a larger system is considered; the course is considered as a "black box" with definite and measurable input and output in terms of student performance; the black box is analyzed into component black boxes; a mock-up is synthesized and tested against its output specifications, and the feedback from testing is used for revision until the system performs as specified. In Figure *i* the box around *Design Architecture and Rationale* includes the definition of system output (performance objectives), and the analysis and synthesis of the design to achieve them.

From the "intermediate design products," the structure of a systematic approach to instructional development can be inferred. These products consist of notes, prose passages, flowcharts, manuscripts, student data, and other ephemeral or rapidly changing forms of information. They result from a sequence of important design decisions.

The three overall aspects of the systems engineering approach can be seen in the list of intermediate products. Context is considered through the needs, goals, and justification which result in "brochure information" useful for potential users or as part of a development proposal. In the box are listed those design products which arise in connection with the synthesis of the "black box." Performance objectives which lead to criterion test and prerequisite test define the input-output specifications. (Other specifications in the form of constraints, such as time, may also be determined.) The analysis of objectives and definition of the system architecture in terms of a hierarchy or other structure of intermediate objectives is the key step in this process. Synthesis of mechanisms for individualization and representational conventions for display and response for each subordinate objective depend on the analysis step. The special training of the instructional designer or design editor (the key professional emerging from the new discipline suggested above) is most critical in the stage of design indicated within the box in Figure *i*.

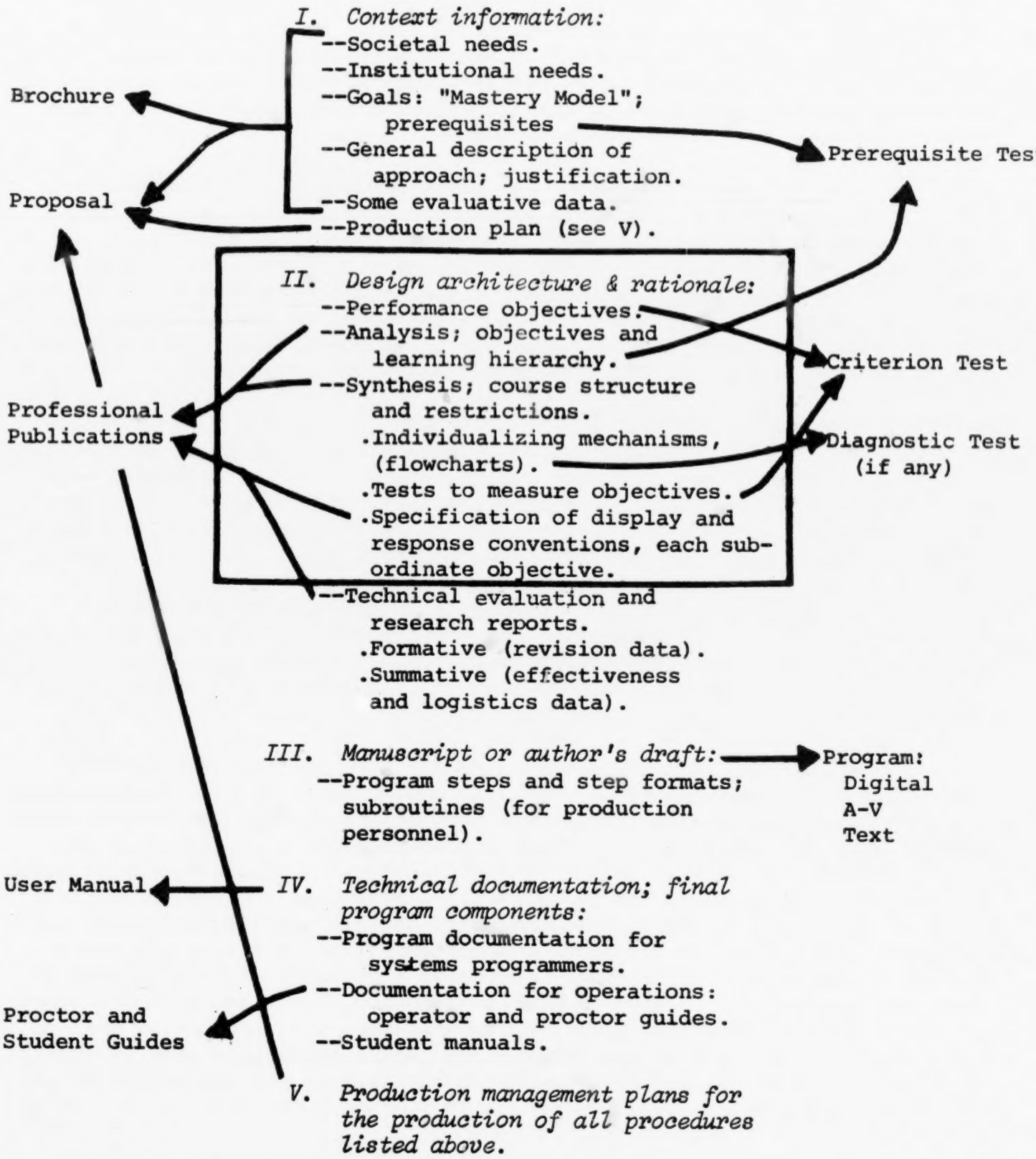
Public Documentation
Intermediate Products
Program Materials
I. Context information:
--Societal needs.
--Institutional needs.
--Goals: "Mastery Model"; prerequisites
--General description of approach; justification.
--Some evaluative data.
--Production plan (see V).
Brochure
Proposal
Prerequisite Test
II. Design architecture & rationale:
--Performance objectives.
--Analysis; objectives and learning hierarchy.
--Synthesis; course structure and restrictions.
.Individualizing mechanisms, (flowcharts).
.Tests to measure objectives.
.Specification of display and response conventions, each subordinate objective.
Criterion Test
Diagnostic Test (if any)
Professional Publications
--Technical evaluation and research reports.
.Formative (revision data).
.Summative (effectiveness and logistics data).
III. Manuscript or author's draft:
--Program steps and step formats; subroutines (for production personnel).
Program: Digital A-V Text
User Manual
IV. Technical documentation; final program components:
--Program documentation for systems programmers.
--Documentation for operations: operator and proctor guides.
--Student manuals.
Proctor and Student Guides
V. Production management plans for the production of all procedures listed above.

Figure 1.--*Products of Instructional Design.*

The notion of testing and iterative revision is implicit in the concept of formative or developmental evaluation. This is more interesting than summative evaluation for the empirically oriented designer, for it can be characterized as a continuing cycle between experiment and adjustment until the program seems to be working. Summative evaluation is most relevant to the production of brochure information and professional publications--to convince others that the program works. It is also useful to obtain field logistics data (distributions of completion times, housekeeping details, etc.) for the user manual.

The concept of formative evaluation provides a strong answer to those critics of serious CAI programming efforts who have often stated, "It is inappropriate to undertake these projects until we know_____." (The blank may be filled in by "how people learn," "what reinforcement to give different students," "what instructional strategy to use for different students," etc.). Happily, we can proceed through, at worst, a combination of rank empiricism (to identify deficiencies) and the use of intuition and common sense to revise it until it does achieve its objectives.

The main concept in the first column of Figure 1 is that proper documentation for CAI programs cannot be determined until it is recognized that there are different audiences for documentation. The potential user needs brochure information, especially the institutional need, which describes a real problem in a real institutional setting that generated the program development. The justification for using CAI to meet this problem is most crucial to the potential user. He also needs an overview of how the program works, a review of its coverage (goals) and objectives, a definition of the target population, and any validation and cost data available. Much of this same information, plus a description of societal needs and a production plan for all products, is needed by a funding agency.

Design architecture and rationale are of interest to sophisticated potential users, but full detail is most appropriate for professional publications. The pressure on universities in the United States from state legislatures to concentrate on teaching undergraduate students is in conflict with the "publish or perish" research ethic. A possible rapprochement is through doing research on the structure, organization, and pedagogical logic of one's discipline in the context of applied curriculum development projects. Such research may lead to important simplifications and reconceptualizations which may actually represent a theoretical contribution to that discipline. For example, Kekule's invention of the benzene ring representation simplified an array of complex phenomena for students as well as for chemists. It can work the other way as well, especially when we attempt to discover functional redundancies which can lead to the definition of more economical and powerful data structures to represent the field of knowledge.

Other audiences who need special forms of documentation include technical personnel who will operate, maintain, and update a complex mainline CAI program, managers, teachers, and proctors who will administer it, and students who will take it.

As a "case study" in instructional software design, this report provides examples and discussion of each of the "intermediate design products" listed in Figure *i*. The final program materials are illustrated by photographs where appropriate, but exist separately as digital code on magnetic disks compatible with IBM 1500 Instructional System and film strips and audio tapes also compatible with this system. Public documentation products are not illustrated explicitly in this report, but as Figure *i* illustrates, and as will be seen by reading the body of this report, brochure information and professional publications are readily obtainable from the material in Chapters I through III. User documentation is not illustrated in this report.

There are, perhaps, certain of the intermediate design products for which this report is especially useful as a case study. These are:

1. *The analysis of goals and objectives which restructured the existing presentation made, based on graphemic similarity, to a performance oriented approach.* Taking the student through the learning hierarchy with seven letters at a time such that at the end of each cycle he could form meaningful utterances proved to be highly effective instructionally and highly motivating for the students. In less than two hours at the terminal, they were able to form meaningful utterances and read words of highly abstruse appearance.

2. *The display and response conventions for each objective in the hierarchy illustrates how, with a rich terminal environment, the creative author can structure an interactive experience which is closely related psychologically to the presentation and response statements of each performance objective.* When the objective required a vocal or written response from the student, this was accomplished with taste and skill by the author even though the computer could not receive vocal or written input. The comparison in these cases was done by the student and, as the evaluation results indicate, with excellent results.

3. *In a previous technical memo from this laboratory, a paper and pencil authoring draft was described.* This memo also described a team approach to authoring in which an instructional designer, a design editor, an author, and a programmer work together in the production phase of the instructional design procedure summarized in Figure *i*. In Chapter IV of this report is a description of the application of the same author input scheme, and a discussion of how it enables an author-programmer-media team to communicate during the production and revision phases of design.

4. *This report surely includes some of the more dramatic evaluation data ever obtained on a CAI program.* The reduction in time from six weeks (22-30 hours) to eight to twelve instructional hours is most impressive. The significantly superior performance in writing ability makes these results doubly impressive.

   Not to be overlooked are the formative evaluation procedures followed in this project. Using the paper and pencil overlay booklets, the early drafts of the program were tested on students and revised accordingly. Extensive debugging and revision followed the implementation of each cycle. Many changes were made which caused the final implementation to transcend the initial design in important ways.

This technical report is based on a doctoral dissertation by the principal author, Dr. Victorine Abboud. This dissertation, an interdisciplinary project between Language Education, Linguistics, and the Computer-Assisted Instruction Laboratory, is an illustration of the output of the "infant discipline of Instructional Software Design." At the beginning of this preface, the claim was made that this discipline will have a far reaching impact on education. In addition to the restructuring of existing fields of knowledge, "Instructional Software Design" should come to be recognized as a new field of study in its own right. It is the fond hope of the authors of this report that universities will begin to establish facilities to provide for this type of doctoral research. We can find no better way to express this hope than through a recommendation which resulted from a recent international conference of scholars interested in governmental policy to encourage the use of computers in education (OECD-NREL, 1970):

--It is recommended that centers be established at or in cooperation with universities to encourage computer-related instructional research, development, and education.

--Universities associated with these centers should institute new options within degree programs and/or new degree programs, where appropriate, for instructional systems researchers and designers, and for administrators and teachers capable of filling new roles. Graduate students involved in these programs might also be involved in programmatic research projects or in curriculum development projects.

--Curriculum development should proceed on two levels: major team efforts to design systems in high-impact subjects; and service to individual faculty members to translate their ideas into computer curriculum materials usable as adjuncts to their classroom or laboraotry.

--The staff for these centers should include scholars, teachers, instructional designers, computer scientists, behavioral scientists, engineers, and measurement and evaluation specialists. Technical staff to support research and development projects, and appropriate hardware resources must be provided.

C. Victor Bunderson
February 1971

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C H A P T E R I

INTRODUCTION

Arabic is one of the major languages of the world today. It is spoken by nearly 100 million people who live in the land that connects three continents at a point of unique geographic and strategic importance. This language is spoken in the countries of North Africa, Egypt, much of Sudan, the countries of the Fertile Crescent, Arabia, the central Asian SSR Uzbekistan, and Malta. It is also used as a foreign language by many more millions of people scattered throughout Africa and Asia as the language of the Quran and Islamic Law. During the Middle Agas, Arab-speaking scholars influenced the West by interpreting Greek thought, and Arabic was the *lingua franca* of the whole Arab-Muslim Empire. Like Latin in Europe, it provided a common medium for the continual growth and dissemination of knowledge and culture. The Arab countries provided an important link between the nations of the West and the newly developed countries of Africa and Asia culturally, economically, and in many other ways. The Middle East is an area of great interest for the whole world; it is the cradle of great civilizations and religions; and it also possesses one of the richest oil deposits in the world.

The teaching of foreign languages has been a matter of great interest to linguists and educators in the United States for a long time, but their main concern has been with European languages. In comparison with such languages as French, Spanish, and German, Arabic received very little attention by the American people until the mid-twentieth century. There are many reasons for this lack of interest. One is that Arabic is a Semitic language and has a very different sound system and syntactic structure from Indo-European languages. But this was not the only reason; there were also political, cultural, and geographical barriers.

The recent advances in transportation and in communication media produced by science and technology, the international radio and television programs, projects of technical assistance, and educational exchange have brought the nations of the world much closer to each other. With this rapid increase in communications and increase in international contacts has come the realization of the need to be able to communicate with people who speak other languages. Learning the language of the people in whom we are interested enables us to acquire insights into their cultures, beliefs, and way of life.that can never be achieved through travel, music, and art alone. The need for cooperation and understanding has never been more deeply felt than in our times.

In the past, the language of communication between the Western and Arab Worlds was either English or French, and Arabs had to learn to communicate in those languages. But with the rise of nationalism and independence in the countries of the Middle East and some nations in Africa, Arabic has come to prominence--and now the situation is different. The United States is making a serious attempt to provide adequate Arabic instruction. In 1947, Arabic was introduced in the Army Language School. Recognition of Arabic as a critical language in the National Defense Education Act of 1958 and the establishment of National Defense Language and Area Centers in American universities since 1959 have helped in increasing the number of students who learn Arabic and in arousing interest in the Arabic language as such.

The world is showing great concern over the state of turmoil and unrest presently in the Middle East, and people are seeking ways in which to bring about peace and prosperity in this area. One of the most effective ways by which help can be given is by understanding the people concerned, their problems, standards, and aspirations. As previously stated, this can best be done by learning the language of the vast majority of the people in this area--which is Arabic. It is therefore of utmost importance that any person serving in an official capacity in this part of the world should learn the language of the people, but it is still of greater importance that more and more citizens of the United States learn Arabic and, thus, in their own way contribute to a better understanding between the Middle East and America.

Spoken Arabic has a great variety of dialects which have differences in phonology, syntax, and vocabulary; but all through the years, a superimposed, prestigious, written standard language has existed side-by-side with the spoken dialects. The contemporary form of this standard language is known as *Modern Standard Arabic* (MSA). This is the language of the radio, press, modern literature, speeches, and scientific and artistic writings. It is the official language of all the Arab States.

The Arabic Writing System

The Arabic writing system is next in importance to the Latin alphabet in the world today. It is generally held that the specific Arabic alphabet originated about the end of the fourth or during the fifth century A.D. It is generally admitted that the Arabic alphabet descended from Nabatean; there is still uncertainty as to how, when, or where it originated.[1]

The Arabs found the 22 letters of the ancient Semitic alphabet were insufficient to distinguish in writing all of the different sounds of South Semitic; therefore, they introduced six new letters:

[thaa'] ث	[THaal] ذ	[Daad] ض
[Zaa'] ظ	[xaa'] خ	[ghayn] غ

[1]David Diringer, *The Alphabet: A Key to the History of Mankind* (3rd ed.; London: Hutchinson), I, 210-215.

Arabic, like other Semitic scripts, is written from right to left, but a special feature of the Arabic alphabet is the large number of diacritical points and slashes. They are employed either to differentiate consonants or to represent vowel sounds. The idea of the use of diacritics is generally believed to have been borrowed from the Syriac script. The present Arabic alphabet, therefore, has 28 letters, all of which represent consonant phonemes, with three that may also represent long vowels under certain conditions. It is not only used for Arabic but has also been adapted to non-Semitic languages such as Persian, Hindustani, Urdu, Sudanese, etc. Arabic script has replaced the Syriac, Coptic, and Persian scripts.[2]

For the American student of Arabic, the writing system presents one of the biggest problems to surmount before real progress can be made in the language. It is therefore of utmost importance that this goal be achieved in the shortest time possible.

The following are some of the ways in which the Arabic writing system poses problems to the American students:

--Arabic is written from right to left.

--The Arabic alphabet is quite unlike the Latin alphabet in the shape of its letters and the multiplicity of the forms of its graphemes.

--Many Arabic letters have different forms, the use of which depends on whether the letter is connected to a preceding or a following letter, to both, or to neither.

--Some Arabic letters have dots above or below them. The number and position of these dots are important.

--The Arabic writing system uses a large number of diacritics, and it offers the additional difficulty that short vowels are first introduced to students as diacritics written above or below the letters, but later they are not normally written and have to be inferred from the context.

--Arabic calligraphy is a fine art. There are many styles, but the most frequently used are the *nasx* and the *ruq9a*. *Nasx* is common in print, and *ruq9a* is used in cursive writing. Some of the same letters have different shapes in these two forms.

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[2] *Ibid.*

Importance of Writing in Early Stages

In the past two decades, the *audiolingual* method has been the most widely used for foreign language teaching in the United States. One of the most important assumptions of this method is that the *natural* and *proper* order of learning a foreign language is listening, speaking, reading, and writing. Brooks proposes

> . . . a sustained experience (of weeks and even months) in listening and speaking to precede training in reading, and then a further period when only what has been heard and repeated should be read.[3]

Only when this is successfully achieved should writing be introduced. The arguments given to justify such a position are that it reflects the way children learn their native language. This does not, however, apply to teaching *Modern Standard Arabic* for two very important reasons, which are given below.

Arabic is taught to adults in the United States. Although it is not taught in very many high schools, *Modern Standard Arabic* is presently taught in universities. The student at this age level has already learned how to read, to study, and to find valuable information from books, dictionaries, and encyclopedias. His needs and experiences are totally different from those of a child first learning to speak his native language.

There are other differences between a child learning his own language and an adult learning a second language. The child's learning mainly depends on training the ear and tongue with some support of the eye, while an adult's knowledge comes largely from books or the support of visual materials. Rivers states: "In our culture, the ability to listen, comprehend, and to retain materials heard but not seen has not been developed."[4] It is true that it is possible to assimilate auditory materials without visual support, but while the auditory ability is being developed, access to a written notation for verification and for aid in recall will relieve the anxiety of many students and so enable them to concentrate on acquiring the new skills. An American adult learning Arabic, which has some sounds very different from English, must hear everything--and hear it clearly. He must also retain everything if he is to learn the oral material presented. If the student is uncertain of himself, is anxious, has poor auditory discrimination, or poor powers of retention, what he has to learn only passes in the air, and he has no support to which to turn except his teacher or classmates (who are not always available).

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[3]Nelson Brooks, *Language and Language Learning--Theory and Practice* (New York: Harcourt, Brace, & World, 1970).

[4]W. M. Rivers, *The Psychologist and the Foreign-Language Teacher* (Chicago & London: The University of Chicago Press, 1964), p. 105.

Much of the student's dilemma is due to his inability to remember strange sounds and unaccustomed sound groupings long enough to rehearse them subvocally and so strengthen the memory trace. Items presented to a learner aurally for a short period of time fade quickly from memory, especially when more new items and sounds are immediately presented. If the teacher or program does not help the student by giving him a written form of the unfamiliar sounds, he will impose some form of his own to which the teacher has no access and which therefore cannot be corrected if necessary. This has often happened in Arabic classes taught strictly by the aural-oral approach. The objection that the orthography of a foreign language will cause associations with the native language and hence lead to interference from native-language pronunciation is not valid when Arabic is taught to American adult students. Arabic script is very different from Latin script, and the sounds and consonants have a near-to-perfect fit.

Another drawback in postponing writing instruction is that correct spelling habits are often delayed. During the strictly aural-oral period, it is impossible to prevent a college student from devising his own *phonetic* spelling. The longer the time lag, the more strongly these spellings become fixed, and the more difficult it is to correct them.

Writing is essential for the study of Arabic. Although it differs from all spoken dialects of Arabic, *Modern Standard Arabic* is the only form of Arabic that is written throughout the Arab countries. The elementary level of *Modern Standard Arabic* (MSA) is normally completed in three semesters at the rate of six hours of instruction a week. At The University of Texas at Austin, where *Elementary Modern Standard Arabic* is used as a textbook,[5] the first ten lessons introduce and drill the phonology and the writing system of MSA. Lessons 1 through 5 deal exclusively with phonology and script, proceeding from sounds that resemble English to those which are foreign to English (this generally takes about three weeks). In Lessons 6 through 10, instructions in phonology and script are continued, but some grammar is introduced. At the end of these ten lessons, the student should have gained the ability to read and write all of the alphabet as well as to know simple grammatical structures. The length of time taken to finish the first ten lessons is about five to six weeks. The students then continue to obtain good knowledge of basic syntactic structures and to learn an adequate vocabulary. The elementary level is followed by an intermediate course which introduces students to more advanced levels of grammatical structures and more intensive reading of short stories, plays, and writings, which would build the student's vocabulary. Thus, it can been seen that a student's rapid progress in achieving the skills needed to learn MSA can be greatly impeded by a lack of proficiency and competence in the Arabic writing system.

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[5]Peter Abboud et al., *Elementary Modern Standard Arabic* (Ann Arbor, Michigan: Inter-University Program Committee, 1968).

During the year 1969-70, the professor in charge of the Arabic program at The University of Texas experimented with *A Programmed Course in Modern Literary Arabic Phonology and Script*.[6] It took five to six weeks (six hours a week) to complete instruction, and from this total number of hours, five to six were used to introduce simple basic dialogues and simple syntactic structures.

Learning to articulate the sounds of Arabic correctly and to achieve proficiency and accuracy in the writing system involves (as for any other foreign language) the establishment of a set of habits, both neural and muscular, that must be so well learned as to become automatic. This is especially true at the beginning stages when new sounds are introduced and taught to students. The language must be taught by producing appropriate stimuli and responses. The response can be learned more effectively when there is immediate confirmation or correction feedback. Therefore, if reading and writing skills of the Arabic language are to be taught successfully, the teacher must invest a large amount of time in the supervision of each individual student in the various tasks required in the acquisition of those skills. Between 40% to 60% of the time consumed during the first few weeks of a beginning class in *Modern Standard Arabic* is used for drills, writing exercises, and pattern practice. In a class of 12 to 15 students, if even the full 50 minutes are used in interactive practice, an interaction is used to mean a two-way communication between either teacher and student or student and student. During the class hour, the individual student has the opportunity to respond individually and receive a confirmation of the correctness or incorrectness of his responses a maximum of five to six times. In an entire two-semester basic language course, he will not have more than 400-500 interactions in Arabic between himself and his teacher. This is a very insufficient number if we really believe that the learning of a foreign language skill is *habit forming strengthened by reinforcement*.

Constant supervision of the students' work is of utmost importance when a program introduces a new and unfamiliar script. Since the orthography of Arabic is not similar to English, the development of the program will demand both discrimination training and response differentiation. This will require much more time and individual instruction than is possible for the teacher in a conventional class period. The amount of time such a program will take in class will sometimes cause students to become tired and therefore to lose interest and motivation in learning Arabic.

There is a great need for a *quicker*, more efficient method which can be adapted in a unique way to *individual learners*, each of whom has his own characteristic initial ability, rate, and even style of learning. A method which will provide the student with rapid interactive feedback and thus decrease the classroom time needed for supervised instructions will free teachers to use the material taught in new and creative ways. Good books have been written for the teaching of Arabic phonology and script, but none of them have fulfilled the above requirements.

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[6]Ernest N. McCarus and Raji Rammuny, *A Programmed Course in Modern Literary Arabic Phonology and Script* (Ann Arbor, Michigan: University of Michigan Press, 1968).

The need for an effective method for teaching Arabic script with optimal efficiency and speed has been recognized by some educators, and books using programmed instruction have been written. But programmed instruction fails in that its feedback, though immediate, is quite restricted in format; its branching capabilities are limited and based on multiple-choice; and it uses only one sense though it is believed that

> . . . the more numerous kinds of associations that are made to an item, the better are learning and retention. Again, the principle seems to indicate against the use of systems of language teaching that employ one sensory modality, namely hearing.[7]

The position taken in this paper is that a well-conceived CAI program in the Arabic writing system will be a more efficient and more rapid method than either convention classroom teaching or programmed instruction.

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[7]Albert Valdman, *Trends in Language Teaching* (New York: McGraw-Hill, 1966), p. 105.

C H A P T E R II

JUSTIFICATION

Although computer-assisted instruction may be viewed as an extension of some methods of programmed instruction, it involves additional capabilities and can be a far superior method of instruction.

> Computers can accept and evaluate responses constructed by the student, can provide almost unlimited branching capabilities, and can branch based on a variety of criteria. They can also control a wide variety of student terminal equipment and in other ways provide far greater flexibility than is possible with simple "teaching machines."[8]

Individualization of Instruction

Conventional class organization keeps all students in lock-step. The teacher must make sure that the whole class understands the lesson, completes all drills, and finishes all exercises before proceeding to the next lesson. He is unable to accomodate individual variations in linguistic aptitude, speed of learning, motivation, attitude, and previous foreign language learning.

There are a large number of differences in the rate of learning various tasks. Even among a supposedly homogeneous population of college students, the differences in the ability to attain mastery of relatively simple verbal-learning tasks produce many problems for the teacher and result in a wide range of performance. This problem is greater when the students have to learn foreign languages, but even more so when the writing system of that language is so different from their own. Arabic presents this problem. Some students are very quick to acquire proficiency in the art of writing Arabic script but may find difficulty in remembering the correct form of the letter in a word (in initial, medial, and final positions) or whether or not that letter is a connector. Other students need more time in actual practice of drawing the new shapes and to associate them with the right sounds. There are many other differences that could be mentioned. The most important problem for the teacher is to be able to allow the student who is slow, both in the ability to write and to retain enough time to practice, to catch up with the faster and more capable students.

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[8]R. T. Miller, *IBM Research Reports* (Yorktown Heights, N.Y.: T. J. Watson Center), p. 2.

In a basic language course, efficient language learning is very dependent upon the number of interactions that occur during the class hour. In a regular class hour, no more than five or six interactions can occur between an individual student and his teacher. At the computer, the student can have at least 50 to 60 interactions (a two-way communication between student and the computer) in a 50-min. session--ten times as many as he can get in class. He will be presented with instructions on how to write Arabic letters, how to discriminate the various forms, and how to associate the sounds with the letters. Each student will be able to work at his own speed, repeating parts of the lesson when necessary or going ahead to the next task. Since the student can spend time at the computer outside the classroom in his free time, there is a very good chance that even the slow students will be able to achieve the required level of learning in a relatively short time. As a result of computer-assisted instruction in first-year German at the State University of New York at Stony Brook, it was found that

> . . . the learning gains from the computer-assisted instruction were proportionately larger for students who did poorly than they were for the best students, so that the students in the lower part of the class tended to catch up to the students at the top . . . . The results are profoundly significant considering that half of our country's student population is average or below.[9]

Although the main task of pronunciation drills and corrections will be that of the classroom teacher, the computer can be of help (even in this aspect of learning).

> Starting from the assumption that the ability to discriminate between two sounds leads directly to the ability to differentiate them . . . . Most researchers report that this assumption is proving generally valid; surprisingly, the most noteworthy feature of self-instructional programmed foreign language courses is the degree of accuracy in pronunciation attained by the subjects.[10]

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[9]Peter S. Rosenbaum, "The Computer as a Learning Environment for Foreign Language Instruction," *Foreign Language Annals*, 2(no.4), May, 1969, p. 459.

[10]Valdman, *Trends*, p. 144.

This assumption seems to be further confirmed by the results of the pilot study of first-year German, where it was found:

> . . . that although the computer-assisted instruction laboratory emphasized textual and not aural exercises, the CAI group performed roughly as well as the non-CAI group in the skills of speaking and listening.[11]

The computer can continuously compare the student's work with the criteria established by the teacher and can branch him to either new material or remedial work, depending on his performance. The computer makes the individualization of instruction easier because it can be programmed to follow the student's successes and failures and to use his performance as a basis for selecting new material and concepts to which he should be exposed next. A student must take an active part in the program and cannot remain passive. He must respond overtly before he can have any response from the computer; this, in turn, forces him to spend more time on a particular learning task and ensures greater learning.

In the Arabic program, the student sometimes has to type the English equivalent to the sound he hears, use his light-pen in choosing the right form of the word or letter he hears, or the right form of the word for which he is given the different independent forms of the letters to be joined. He can also write on the cathode-ray tube (CRT) with a special pen (with the correct form of the letter or word appearing through his writing for comparison).

Immediate Feedback

In conventional classroom practice, reinforcement, whether positive or negative, is rarely immediate and very often is not given at all. A teacher trying to teach a foreign language to a class of 12 to 15 students or more finds it very difficult to correct the Arabic handwriting of every student in the class for every letter or word he attempts. The student writes an exercise which may not be returned to him for a few days. By the time it is returned, he has already gone on to learn a new letter or form and is not interested in rewriting the whole exercise. Probably his only interest by then will be the grade given him. In a very small class of two or three students, the teacher can certainly give immediate responses to the student's performance by pointing out exactly the errors they made and he can help them to achieve proficiency in writing, but such a situation is rarely possible in any university at the present time. Practice does not make perfect unless the desired behavior is reinforced immediately. The student must know whether he is right or wrong within a very short period of time, or he may learn undesired responses.

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[11]Rosenbaum, *Learning Environment*.

Computers are highly desirable devices for controlling instructional interactions as they permit rigorous control of the student's behavior. He is told whether his answer is correct or wrong after he has given a response. After each step, the student must have confirmation of the correctness or incorrectness of his responses. The shorter the time span between responses or confirmation, about 5-sec., the more effective is the learning of the correct forms, or the extinction of wrong responses. Computers have a great speed of operation; a computer can simultaneously handle a large number of students and each of them can be given an immediate response. The student does not need to wait for more than a second or so to know whether he is right or wrong. In learning how to write Arabic, this will be a very great help to each student and may give the student more motivation and desire to go on to learn more about the Arabic language, its syntactic structures, and its rich literature.

Impact of CAI on Teachers of Arabic

The proposed CAI program in the Arabic Writing System is to be taught in conjunction with classroom instruction. The program will be able to achieve a certain amount of teaching rather than being used for drill exercises only. This program will do the actual teaching of the cursive writing to the students and will also provide a practice in sound discrimination. The program will also achieve a great deal in teaching the students how to read the printed form of Arabic. With the help of workbooks, the student should be able to achieve proficiency in Arabic writing by using this program only, but where pronunciation is concerned, the teacher will still be the main source of information and correction. When the students have their classroom sessions, the teacher will be able to use the letters (especially chosen to form words in context as quickly as possible early in the course) in forming words and sentences.

Systematic Collection of Data and Update Capabilities

Another pressing problem that is faced by teachers is to find effective ways to keep and use information about the students' past performance. A gifted teacher will store in his memory many facts about the past performance of his students and take advantage of these facts in preparing his next presentation, but this is a very complicated matter when it concerns many students over many weeks. The ability of computers to collect student data will be a very powerful impetus to the improvement of teaching. The computer can store every response that is made by the student as he proceeds through the course. These data can be made available to the teacher in the form of convenient summaries. Thus, it is possible to request data for all students or for specific students, for all responses or for any specific operation (correct or incorrect answers, number of attempts, etc.).

> By periodically obtaining data such as these, it would be possible for a remotely located monitor to maintain a fairly continuous check of the students' rate of progress and to detect any problems in their adherence to their assigned schedules of study.[12]

The computer can help the teacher to be better informed about his students' progress than is possible in an ordinary classroom situation.

Since course material is stored in a computer's memory, it is easy to change. Computer-assisted instruction permits an author to write the initial version of his course and then to administer his program to a small number of students. Finding out how well the students performed and how many errors were made would help to determine where changes are necessary. This is currently being done with the CAI program in the writing of Arabic at The University of Texas at Austin. Depending on the results of the work of the students, additional materials can be added, or unwanted material can be deleted. Thus, the program can achieve excellence without having to rewrite it. This procedure is certainly not possible in the production of books or programmed-instruction text.

Summary

In this chapter the following points were discussed:

--The need for more and more Americans to learn Arabic, the language of many people who live in an area of great strategic, political, and economic importance. Learning Arabic will certainly help other people to understand the desires and aspirations of the people who live in this area.

--Learning the Arabic Writing System requires much time and individualized instruction. It is therefore important to find a quicker and more efficient method than the conventional classroom situation.

--Although learning the Arabic Writing System is not an end in itself, it is one of the first and most basic steps in learning the Arabic language, its syntactic structure, and its rich literature.

--A computer-assisted instruction program will be a great help in reducing the time used in learning to write, in keeping the students motivated, and in giving individualized instruction. Such a system has the advantage of being flexible, and parts of the course can be deleted or expanded. Another advantage is that it can keep a record of all student achievements--something teachers find very difficult to do.

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[12]David Markle, "Controlling Behavior Changers' Behavior, *AV Communication Review*, 16(no.2), 1968.

This is the first CAI program for Arabic script and, in fact, the first for any other Semitic script. This program is designed to be the first part of a broader CAI program for first-year *Modern Standard Arabic* and will, it is hoped, widen the scope of Arabic language learning as a whole in the United States.

C H A P T E R III

INSTRUCTIONAL DESIGN

Analysis

Objectives

The main goal of this program is to teach American (or English-speaking) adult students to write Arabic correctly with a good handwriting in the shortest time possible and to keep them motivated and interested in learning the Arabic language as such. Though this program is prepared especially for the Arabic writing system, students will be taught to discriminate sounds and to read simple material. They will also be trained to read both the cursive and printed forms of Arabic.

Behavioral Objectives

The behavioral objectives that a student must achieve upon completion of this CAI program are the following:

(1) Given the letters of a word in their independent forms, the student should be able to choose the correct form of the word from two varieties displayed on the cathode-ray tube (cursive form).

(2) Given independent letters which make up a word, the student should be able to write the word correctly (cursive form).

(3) Given pairs of minimally different words in their written form, the student should be able to choose the correct form of the word heard on the tape (cursive and printed forms).

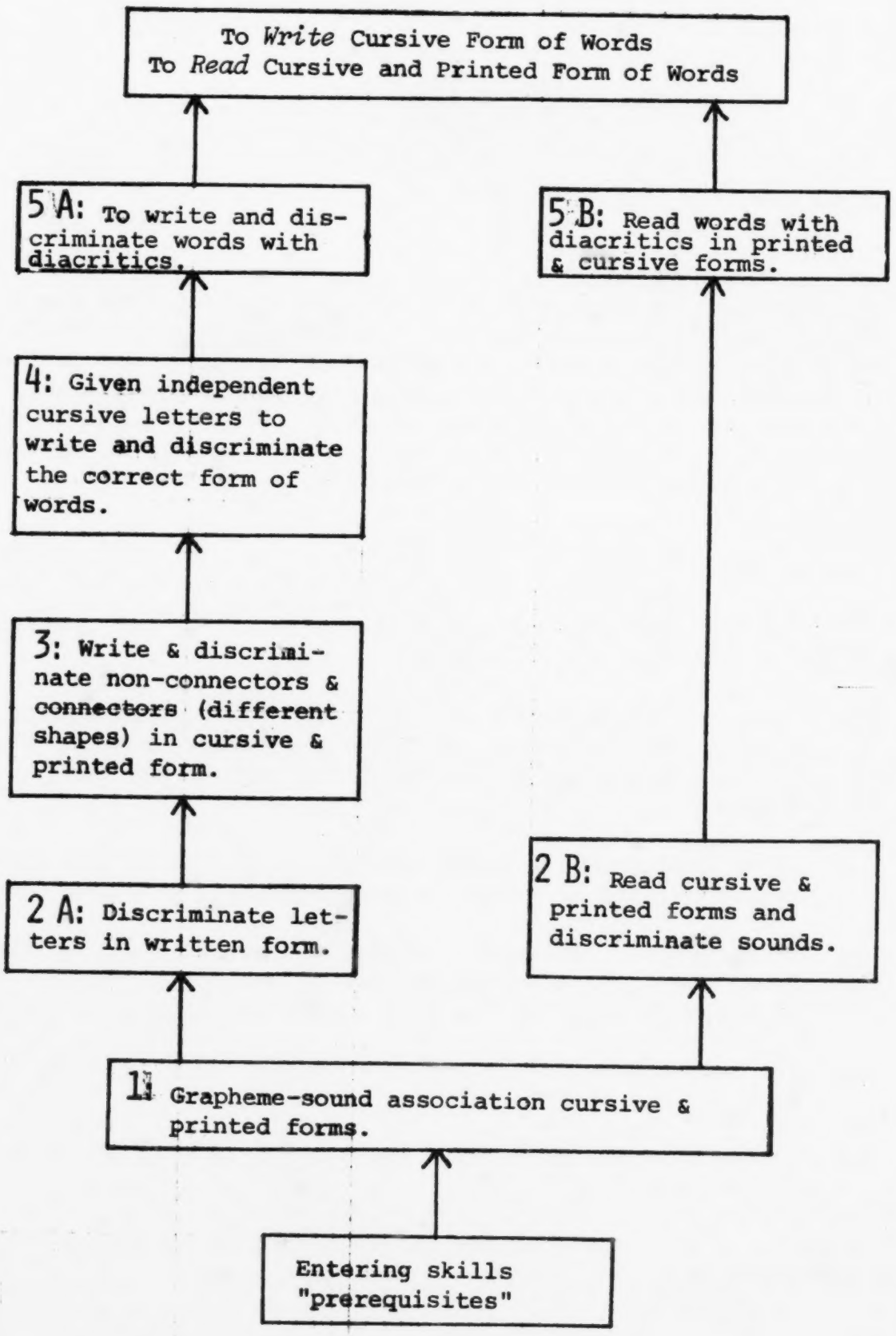
(4) The student should be able to read simple words using diacritics (cursive and printed forms).

(5) The student should be able to write words that are dictated to him on tape.

The standard expected from the students for each task is to obtain 80% to 90% correct in any given test.

FIGURE 1

LEARNING HIERARCHY OF THE ARABIC WRITING SYSTEM


To *Write* Cursive Form of Words
To *Read* Cursive and Printed Form of Words
5 A: To write and discriminate words with diacritics.
5 B: Read words with diacritics in printed & cursive forms.
4: Given independent cursive letters to write and discriminate the correct form of words.
3: Write & discriminate non-connectors & connectors (different shapes) in cursive & printed form.
2 A: Discriminate letters in written form.
2 B: Read cursive & printed forms and discriminate sounds.
1: Grapheme-sound association cursive & printed forms.
Entering skills "prerequisites"

DIETZGEN 100% Rag Tracing Vellum

Learning Hierarchy

For students to achieve the objectives of this course, it was found necessary to construct a learning hierarchy of intermediate objectives having prerequisite relationship to one another. These intermediate objectives are obtained by finding out how much the learner should accomplish to achieve success in the next higher objective.

> Subordinate learning sets are conceived as having the function of mediating positive transfer to higher level learning sets throughout the hierarchy, and ultimately to the final task.[13]

A block diagram of the learning hierarchy is given in Figure 1.

Prerequisites

The prerequisites for taking this CAI course are very few. The student should know how the computer functions (there will always be proctors to help, and a handbook describing the various terms used in the program will be available to the students). He should also know how to use a typewriter keyboard (though the use of the keyboard will be very limited). The student must be registered in a first-year *Modern Standard Arabic* course, as this program is to be used in conjunction with classroom teaching.

All students will be tested on the contents of this program upon its completion. (Time will be given when Cycle 1 is tested on students.)

Content Analysis

The Arabic alphabet, which is written from right to left, consists of 28 letters. From a calligraphic point of view, there are two important divisions: *connectors* and *non-connectors*.

There are six non-connectors which, while joining a preceding connector, cannot be jointed to a following letter. These non-connectors are:

ا و ر ز د ذ

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[13] R. Glaser (Ed.) *Teaching Machines and Programmed Learning, II.* (Department of Audio-Visual National Education Association of the United States, 1965), p. 408.

TABLE 1

THE ARABIC LETTERS IN THEIR ALPHABETICAL ORDER
(Cursive)

NAMES	FINAL	MEDIAL	INITIAL	INDEPENDENT	TRANSCRIPTION*
'alif	ـا			ا	aa
baa'	ـب	ـبـ	بـ	ب	b
taa'	ـت	ـتـ	تـ	ت	t
thaa'	ـث	ـثـ	ثـ	ث	th
jiim	ـج	ـجـ	جـ	ج	j
Haa'	ـح	ـحـ	حـ	ح	H
xaa'	ـخ	ـخـ	خـ	خ	x
daal	ـد			د	d
THaal	ـذ			ذ	TH
raa'	ـر			ر	r
zaay	ـز			ز	z
siin	ـس	ـسـ	سـ	س	s
shiin	ـش	ـشـ	شـ	ش	sh
Saad	ـص	ـصـ	صـ	ص	S
Daad	ـض	ـضـ	ضـ	ض	D
Taa'	ـط	ـطـ	طـ	ط	T
Zaa'	ـظ	ـظـ	ظـ	ظ	Z
9ayn	ـع	ـعـ	عـ	ع	9
ghayn	ـغ	ـغـ	غـ	غ	gh
faa;	ـف	ـفـ	فـ	ف	f
qaaf	ـق	ـقـ	قـ	ق	q
kaaf	ـك	ـكـ	كـ	ك	k
laam	ـل	ـلـ	لـ	ل	l
miim	ـم	ـمـ	مـ	م	m
nuun	ـن	ـنـ	نـ	ن	n
haa'	ـه	ـهـ	هـ	ه	h
waaw	ـو			و	w or uu
yaa'	ـي	ـيـ	يـ	ي	y or ii

*This transcription was chosen to facilitate its use on the computer.

The remaining letters of the alphabet are connectors. Each can have one of four forms:

(1) *Independent:* Occurring either at the beginning of a word or in a word after a non-connector.

(2) *Final:* Joined to a preceding letter only.

(3) *Initial:* Joined to the following letter only.

(4) *Medially:* Joined on both sides.

(See Table 1 for Arabic letters in their alphabetical order.) The method of transcription was chosen to facilitate work on the computer.

*Various Uses of Diacritics**

(1) *Short Vowels:*

ـَـ	fatHa	[a]	written above the consonant فَـ	[fa]
ـِـ	kasra	[i]	written below the consonant بِـ	[bi]
ـُـ	Damma	[u]	written above the consonant تُـ	[tu]
ـْـ	no vowel		written above the consonant دْ	[d]

(2) *Nunation:* The indefinite case-endings of Classical Arabic are indicated by the device of doubling the vowel-sign:

ـًـ	[an]	written mainly above 'alif
ـٍـ	[in]	written below the consonant
ـٌـ	[un]	written above the consonant

(3) *Tashdiid:* When it is required to double a consonant, ّ is written above that consonant:

رَبَّ [rabba]

(4) *Madda:* When a glottal stop and a long fatHa is required, ~ is written above the 'alif:

آمِنٌ [aaminun]

*A more detailed analysis of diacritics is given in the grammar instructions in class by the teacher.

(5) *Hamza:* The hamza, ء , represents a glottal stop and can be written above or below vowels or alone. The letters

ا و ي

are called the "seat" of the hamza, and these letters have no phonetic value:

أُمٌّ ['ummun]

(6) *Hamzat lwaSl:* No utterance can begin with a cluster of two consonants; if such a word occurs, a "helping vowel" preceded by a hamza is used, and written, on an 'alif. For example:

شْرَب ← إِشْرَب

If that word follows another word or prefix, the vowel of that word or prefix serves as the helping vowel. An 'alif is still used, but the hamza is now replaced by a waSla, ٱ . For example:

وَ + إِشْرَب ← وٱشْرَب

Table 2

Difference Between Cursive and Printed for One Letter

	Printed	Cursive
(1)	شـ	ـشـ
(2)	ـش	ـش
(3)	ـشـ	ـشـ
(4)	ـشـ	ـشـ

Cycles

With so much to assimilate, this CAI program in the Arabic Writing System will be divided into four cycles. In each cycle the student will be presented with seven letters and a few diacritics. The choice of the letters and the order in which they are presented are of great importance. Teaching the Arabic system has been approached in several ways. Linguists, like T. F. Mitchell, emphasized the importance of studying letters. In his book on Arabic writing, he presented the letters in alphabetical order with similar letters grouped together.[14] Others start by introducing letters that have the same sound as English and then proceed to those completely foreign sounds.[15] Still others introduce the students to short and long vowels, and then combine them in words containing plain versus pharyngealized sounds.[16] Lastly, other writers teach students the unconnected letters first, and then gradually introduce those that have different shapes in initial, medial, and final positions in words.[17] Most books apply no specific criteria in presenting the letters other than sounds--their similarity to English sounds or their contrast to each other. The main objective of this course is to teach writing and to make such an achievement interesting and useful as early as possible.

The effectiveness of a CAI capability of quick and numerous interactions is not sufficient in itself, but these interactions have to have meaning and relevance to the subject matter taught in class. The need is to provide the student with the ability to discriminate, write, and read letters that can help him to form meaningful words and sentences very early in the first-year Arabic course and thus decrease the boredom and monotony of the first few weeks of learning how to write. Creative action on the part of the student in constructing words and sentences will certainly be an incentive for him to continue learning the Arabic language (with the help of the teacher).

Two important points or aspects were taken into consideration in the choice of the letters and the order of their introduction in this program. The statistical distribution of the letters of the Arabic alphabet and their order of frequency were carefully studied.[18] The results gave a clue as to which letters should be taught first. But this was found to be insufficient evidence for the purpose of this program. It was also important to determine

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[14]T. F. Mitchell, *Writing Arabic: A Practical Introduction to the Ruq9ah Script* (London: Oxford University Press, 1953).

[15]Abboud, et al., *Elementary MSA*.

[16]Sami A. Hanna and Naguib Greis, *Writing Arabic* (Salt Lake City: University of Utah Printing Service, 1965).

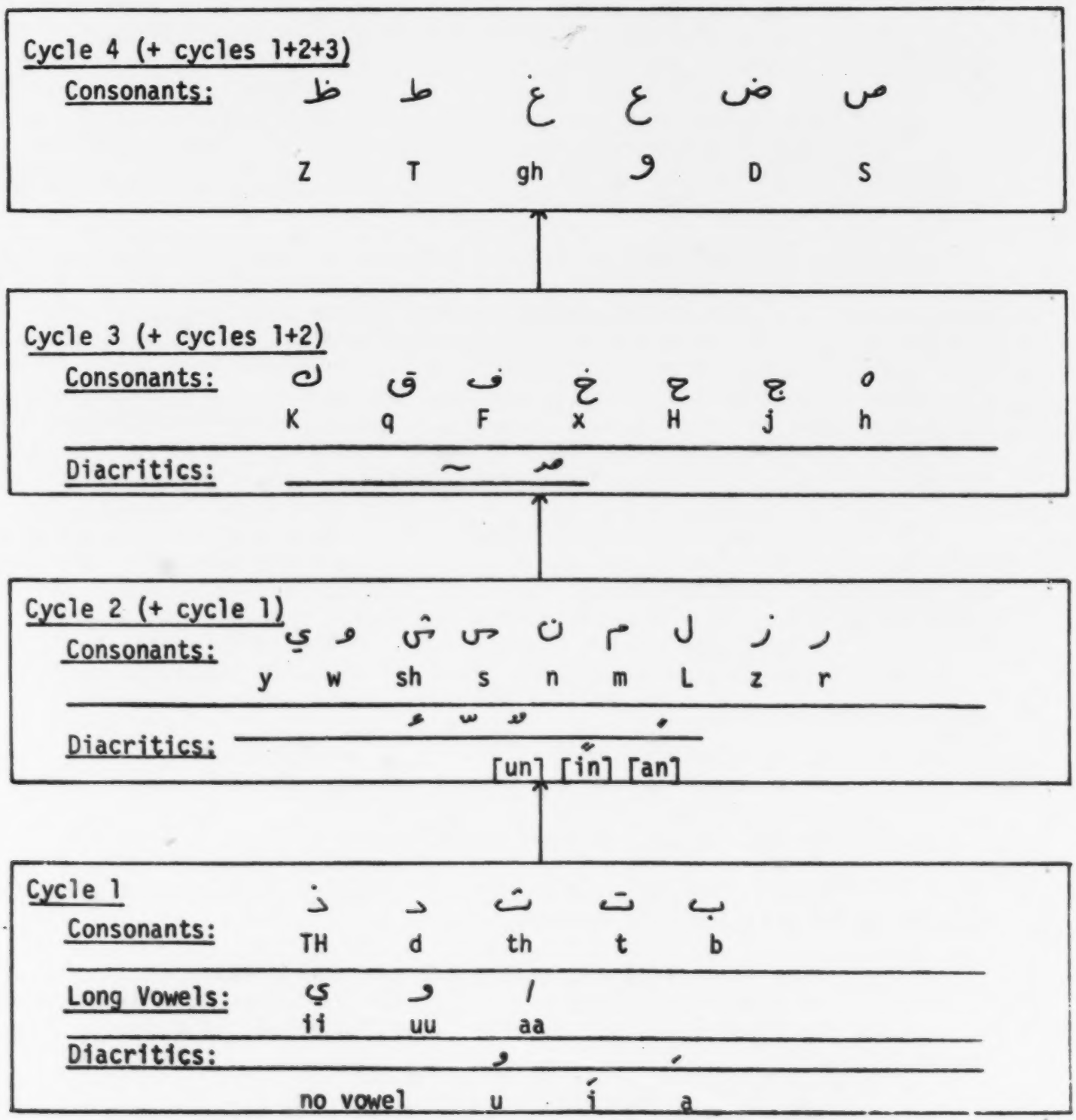
[17]John B. Carroll and Graham Leonard, *The Effectiveness of Programmed "Grafdrils" in Teaching the Arabic Writing System* (Cambridge, Massachusetts: Laboratory for Research in Instruction, Graduate School of Education, Harvard University, 1963).

[18]Nada Tomiche, *Le Parler Arabe du Caire* (Paris: Mouton Co., 1968), p. 66.

FIGURE 2

HIERARCHY OF CYCLES IN TERMS OF ORDER OF THE 28 LETTERS AND 11 DIACRITICS OF ARABIC

(Refer to Table 1 for the letters in alphabetical order.)



which were most useful letters for a beginner to form meaningful words and short sentences in Arabic. Various books were studied, but special attention was given to the words which occurred in the early lessons in *Elementary Modern Standard Arabic*[19] (the book which is to be used in classroom teaching in conjunction with this CAI course in the Arabic Writing System). The order in which the letters are presented is given in Figure 2.

These are some of the examples which the student should be able to write at the end of Cycle 2 (the cycles have been tested on some students and the results were very encouraging, but much more testing will be necessary to have definite conclusions).

FIGURE 3

Examples:

ENGLISH	ARABIC
"Where are you from?"	مِن أين أنتَ ؟
"Suzanne is from Paris."	سوزان مِن باريس.
"I am from Lebanon."	أنا مِن لُبنان.
"I am from Lebanon and you are from Tunisia."	أنا مِن لُبنان و أنتَ مِن تونِس.
"Amin is an instructor."	أمين مُدَرِّس.
"Mary is the principal of a school."	مَريَم مُديرَةُ مدرسة

[19]Abboud, et al., *Elementary MSA*.

By the third week, the student should be able to achieve greater capabilities in forming long and more complex sentences. At the end of the fourth week, the student should be able not merely to write all forms of the letters, but should have learned some vocabulary and syntax in class.

The main objectives of each cycle are the same as those of the whole course, i.e., proficiency in writing and reading all the different forms of the letters as well as the diacritics introduced in the cycle and also those of preceding cycles. The intermediate objectives for the cycles are also the same as those of the program. They will be described in full detail in the instructional design synthesis section of this program (see Figure 1).

Every cycle will give a review of all the letters that have been taught in previous cycle or cycles to make sure that the work has been assimilated before new material is presented. Though new material in the cycle will be given prominence and will be drilled, all letters already taught will continue being drilled and tested. The students will be given the Arabic letters in their alphabetical order at the end of Cycle 4, in both cursive and printed forms.

Tests

Tests will be given frequently in every cycle to make sure that every intermediate objective has been attained.

Tests will be of different types. Some will be self-evaluation tests. The student will be presented with a number of questions. If he answers correctly, he is given confirmation and may go on to the next question. If his answer is wrong, he will be told his answer is not satisfactory. If at the end of such a test a student has made any mistakes, he has to repeat the test.

A second form of testing is for measurement or grading. If he answers 90% or more of the questions correctly, he goes on to the next lesson; but if less than 90% are correct, he is told that because his grade is low, he has to repeat the test.

A third kind of test is also for the purpose of grading; however, in this case, if the student does not receive a satisfactory grade, he is branched to a review of the work, and then he is allowed to try the test again.

In preparing this program, many questions that needed to be answered were found. Such answers may be provided through evaluation of different formats of presentation and different techniques in testing. Some of these questions are:

--How many attempts should the student be allowed on a test before he goes on to the next lesson?

--Should the student be allowed to continue if he does not get all the answers correct, even after a second attempt has been permitted?

--How many tape replays should the student be allowed for a sound or word?

--Should there be a certain limit of time in answering all tests?

It is hoped that by giving various types of approaches to certain problems, some of these questions will be answered when this program is used.

Synthesis

Having defined the objectives and intermediate objectives of this program and having described the activities and products by which its success will be measured, the next step is to make certain that the available terminal devices can contribute in a unique way to the attainment of these objectives. It was important to determine the interface capabilities of these terminal devices. A wide range of display and response modes is necessary for language learning.

> The more variety an author can incorporate into his presentation, the more interesting and enjoyable the student's learning experience will be.[20]

The IBM 1500 Instructional System permits the author to develop a course that enables the student to learn how to write Arabic and to help him, to a considerable extent, to read it, too. (Most pronunciation drills will be provided in the classroom by the teacher.)

Computer Capabilities

As this program for the Arabic writing system is written for use on the IBM 1500 Instructional System and reference to its various parts will be mentioned in the design of the interface, a short description is given of this particular system.

The 1510 Instructional Display. The 1510 Instructional Display contains a cathode-ray tube (CRT) for display of alphabetic and numeric characters or images. It is under operating system control, as directed by the course. A system dictionary is used to display all messages in English from CAI programming system to the instructional display.

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[20]Most information given about the IBM 1500 Computer will be taken from the "IBM 1500 Coursewriter II Author's Guide," 1968.

In addition to the system dictionary, any course can use as many as three 128-character dictionaries designed and loaded by the user. The multiple dictionary facility makes it possible to design special characters required in teaching a non-Latin script like Arabic.

The Light Pen. A light pen can be used by the student to register his responses. A student points to a specific location on the screen, thereby indicating his response to a question displayed on the CRT or asked by an audio message. The course can be written to determine that the student has given the correct or wrong response. The student's response is recorded when he pushes the pen against the screen on a specific area. Once the response has been given, the system will not accept any other response.

The 1518 Typewriter. A keyboard will be available to permit the student to enter his responses. The student's responses are displayed on the 1510 CRT screen. A cursor symbol (i.e., □) is used to indicate where the next character will be displayed on the screen.

The 1512 Image Projector. The 1512 Image Projector (IP) holds a display screen 7 in. x 9 in. in size on which filmed material can be projected in black and white or in color. It is a table-top device and can be controlled by the computer. Each frame is addressable, and the system selects each frame for display as directed by the course.

The 1506 Audio Tape Unit. The Audio Tape Unit plays and records messages on magnetic tape. Audio messages can be played through earphones, and recordings can be made through a microphone attached to the instructional station. Each tape cartridge can hold as much as two hours of messages. Author-prepared messages can be recorded, or a student may record on a designated track. The tape can be moved forward or backward as directed by the author is his course presentation. Messages can be of variable lengths.

Interface Specifications for Intermediate Objectives

The goals of this program, the behavioral objectives, and the learning hierarchy have been clearly defined. These provide a sound basis for selecting materials, instructional methods, and media for the presentation of intermediate objectives.

> In addition to its other advantages, a correct analysis is the foundation for tasteful and effective course synthesis. . . . the hierarch, forms the basis for the design of individualization and its description in flowchart form. The list of objectives is the basis for the specification of interface requirements, the diagnostic and curriculum-imbedded tests, and the terminal parts of the sequence of steps for each sub-objective.[21]

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[21]C. Victor Bunderson, "The Computer and Instructional Design," Computer-Assisted Instruction Laboratory, The University of Texas, Austin, 1969.

Therefore, the next step is to analyze and design the best and most appropriate display of the subject matter to the student, the responses by which the student works with the subject matter, and the feedback display which will provide optimal conditions of learning for each of the intermediate objectives in the learning hierarchy (see Figure 1) and for the program as a whole.

Subject-matter properties and requirements for learning can be dictated by the design of the interface, but the author, too, must decide what is the best form of presentation under which the best learning can be accomplished for the different tasks.

Analysis of learners' traits and differences in capabilities and aptitudes can raise such questions concerning whether or not the subject matter is to be presented in such a progression that will be effective in leading all students to terminal behaviors following the same path or in a progression which anticipates student problems and which therefore provides branching possibilities. As intermediate objectives are the same for all cycles, examples are chosen from the different cycles and shown in appendix.

Objectives

Objective 1: Grapheme-Sound Association. An introduction is first given to the students about the differences between cursive and printed forms of Arabic script. They are also told that Arabic is written from right to left, and they are then introduced to the two kinds of letters--connectors and non-connectors.

In the next lesson, the student is introduced to the new letters he is to learn in that cycle. The student has an Arabic letter displayed on the CRT and he also hears the sound which corresponds with the letter. The sound is also given in an Arabic word, and it is then repeated twice. A brief interval is then given during which time the student is asked to mimic the sound. The sound is then heard again for the third time. The student may ask for the whole process to be repeated or he can proceed to the next sound and letter. The character is written in cursive form on the CRT. When all seven sounds and letters have been displayed and heard, the student is allowed to have the whole lesson repeated again (see Figure 4).

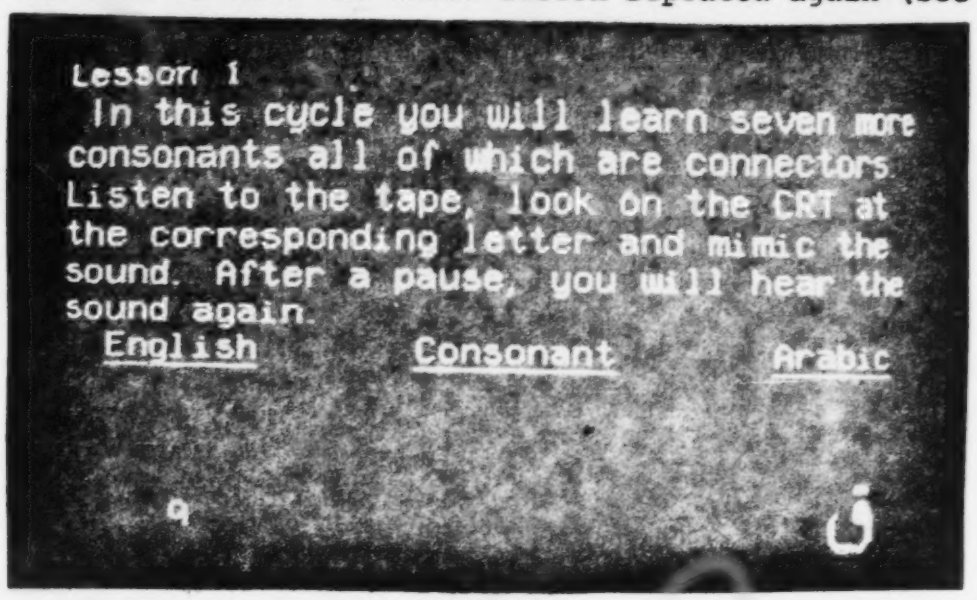
Lesson 1
In this cycle you will learn seven more consonants all of which are connectors. Listen to the tape, look on the CRT at the corresponding letter and mimic the sound. After a pause, you will hear the sound again.
English
Consonant
Arabic
q
ق

FIGURE 4

Objective 2: Discriminating and Reading Cursive and Printed Forms of Sounds. When the five letters have been taught, the student has a review of all seven new letters displayed on the CRT. At the same time, the student is also shown the printed form of these five letters on the IP. Both remain displayed at the same time so that the student can learn to associate between the cursive and printed form of the Arabic writing system.

The student is then asked to read all the letters. When he is ready, he can press the space bar and hear all the sounds of the displayed letters read on tape. He can repeat this part or go on to the next lesson.

As stated previously, the drilling and corrections of sounds have to be done by the classroom teacher, yet it is believed that the student will achieve a considerable degree of accuracy by listening carefully and mimicking the sounds heard on tape at the terminal (the sounds are given by the author of the course, a native speaker of Arabic) (see Figures 5a and 5b).

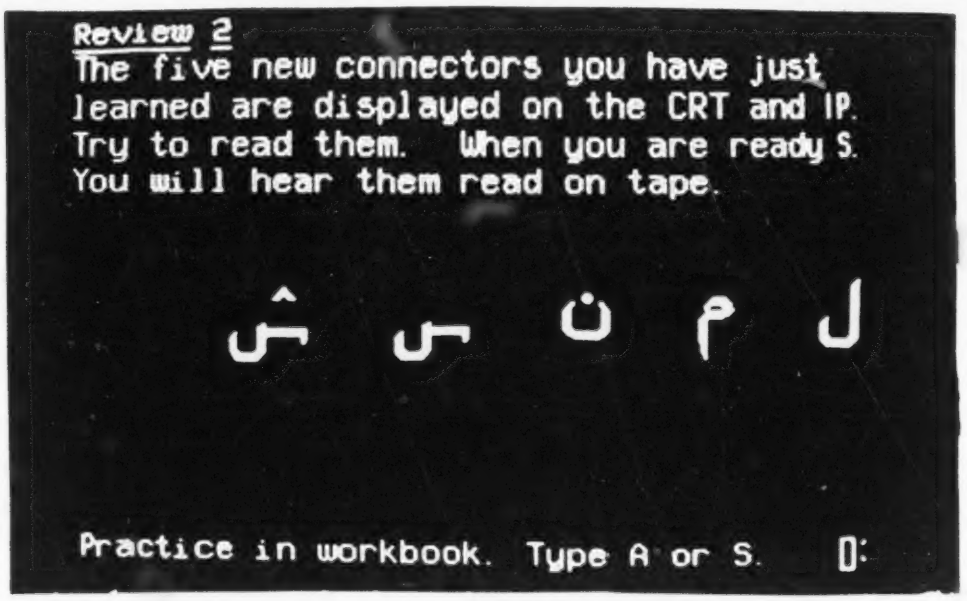
Review 2
The five new connectors you have just learned are displayed on the CRT and IP. Try to read them. When you are ready S. You will hear them read on tape.
ش س ن م ل
Practice in workbook. Type A or S. D:

Figure 5a

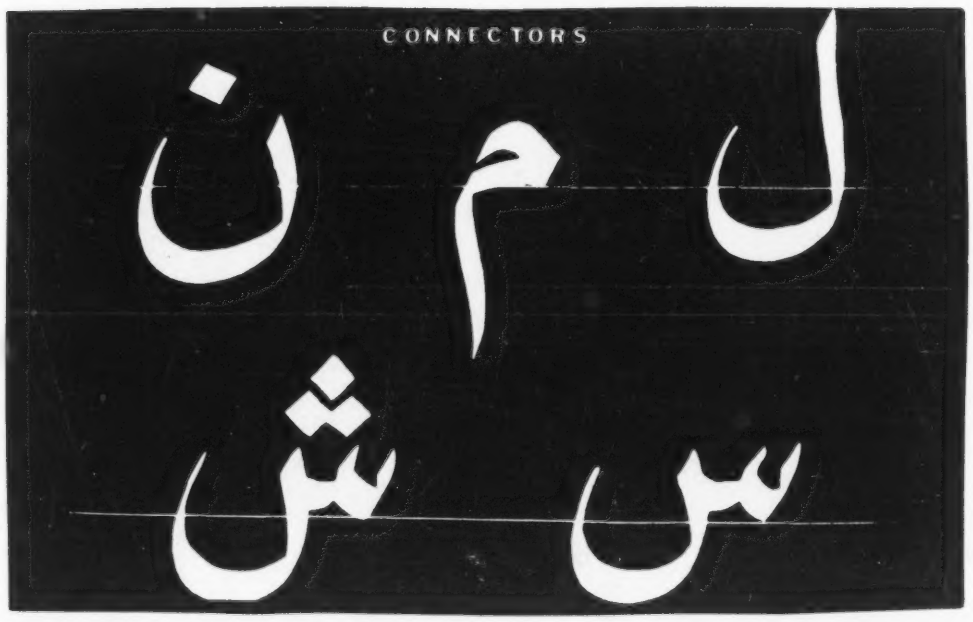

Figure 5b

At the end of the lesson for teaching the students to discriminate the sounds and letters and to read the various letters, two tests will be given. The first one will be a self-test. The student is given an Arabic letter displayed on the CRT, and he is asked to type the equivalent English letter. If he is correct, he is given some form of encouraging statement (Figure 6a). If he is wrong, he is told his answer was incorrect. After a pause, the correct answer is then provided (Figure 6b). If he has any mistakes, he is to repeat the test; otherwise, he goes on to the next test. It is believed that error-correcting hints are helpful to the student.

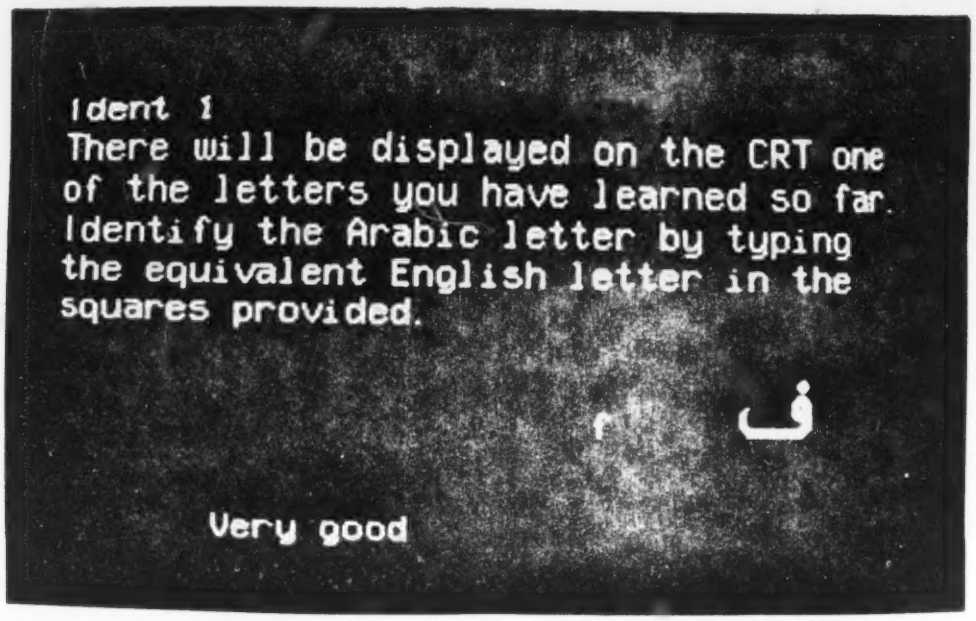
Ident 1
There will be displayed on the CRT one of the letters you have learned so far. Identify the Arabic letter by typing the equivalent English letter in the squares provided.
ف
f
Very good

Figure 6a

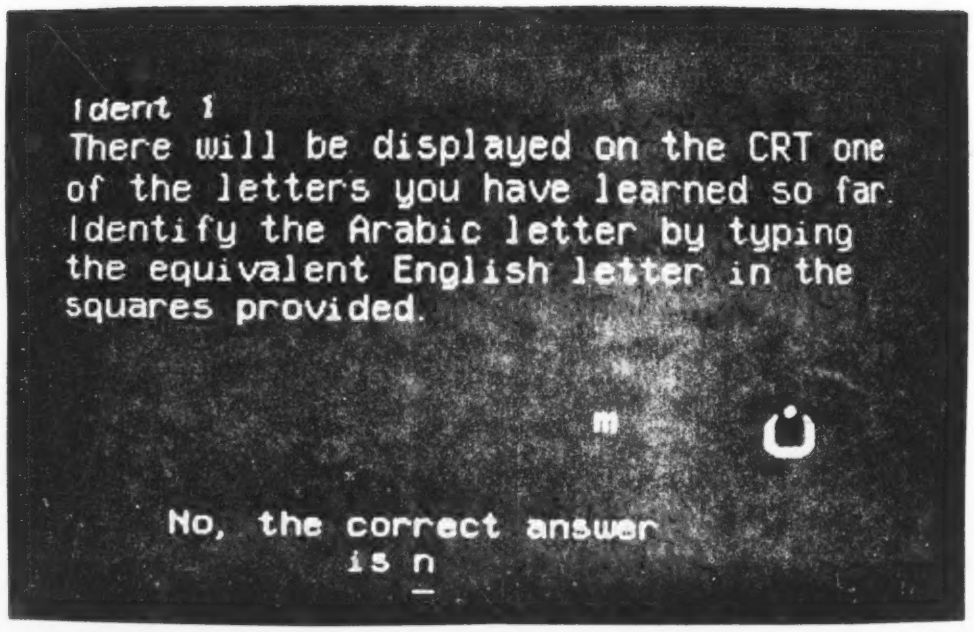
Ident 1
There will be displayed on the CRT one of the letters you have learned so far. Identify the Arabic letter by typing the equivalent English letter in the squares provided.
ن
m
No, the correct answer is n

Figure 6b

The next test is for the purpose of grading. The student is given a number of questions. In each question three Arabic letters are displayed on the CRT. The student is asked to listen carefully as a sound is repeated twice on tape. He then has to push his light pen on the letter which corresponds to that sound. If the student chooses the correct letter, he is given confirmation (Figure 7a). If he is wrong, he is corrected (Figure 7b). If the student gets 90% of the questions correct, he is branched to the next lesson, but if he has more mistakes, he is branched to a review and then is asked to repeat the test.

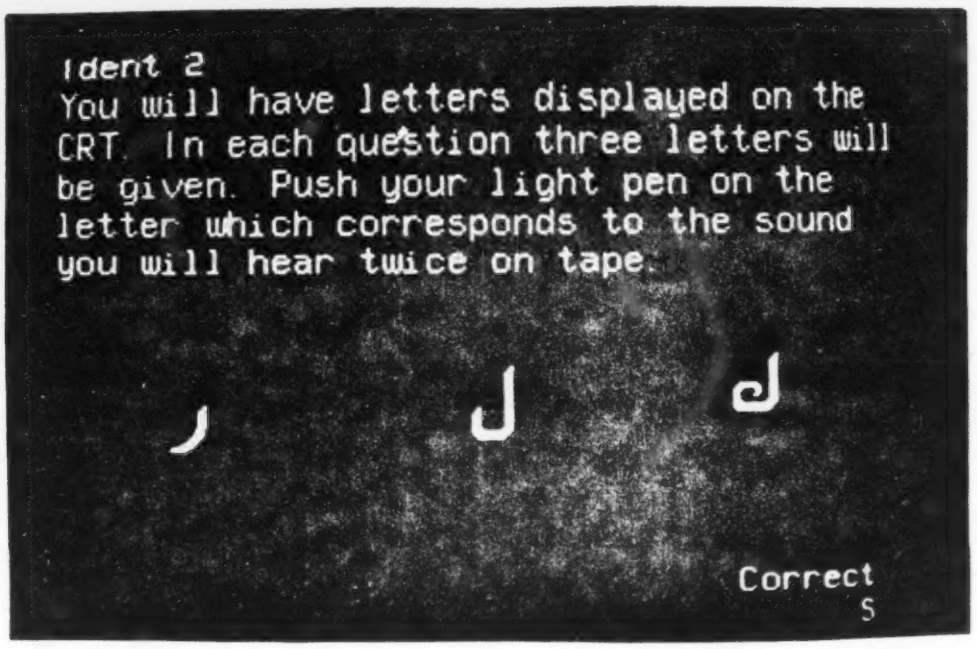
Ident 2
You will have letters displayed on the CRT. In each question three letters will be given. Push your light pen on the letter which corresponds to the sound you will hear twice on tape.
Correct
S

Figure 7a

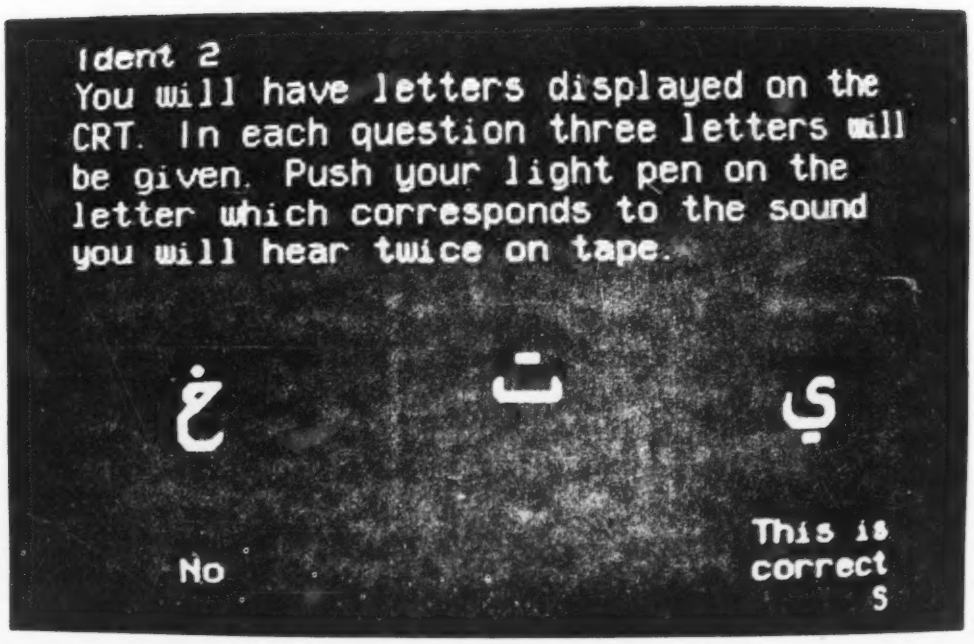
Ident 2
You will have letters displayed on the CRT. In each question three letters will be given. Push your light pen on the letter which corresponds to the sound you will hear twice on tape.
No
This is correct
S

Figure 7b

Objective 3: Discrimination and Writing of Various Forms of Letters. This task is the most important one in this program and will be dealt with in detail. Much instruction and practice are given to achieve this goal.

The students are now shown how a non-connector can be connected to the letter which precedes it, but not to the letter which follows it. Also, they are reminded that non-connectors never change their shapes.

For connectors, which can be joined to both the letters which precede or follow them, a full description is given of how their shapes differ in initial, medial, final, and independent forms. To ensure that the students will learn how to write correctly, guide lines will be given at the beginning and then withdrawn gradually. The letter will be displayed with a *line* to show its position, *arrows* will point in the direction in which the hand will move, and *numbers* will indicate the order in which the different parts of the letter are formed (Figures 8a, 8b, 8c, and 8d).

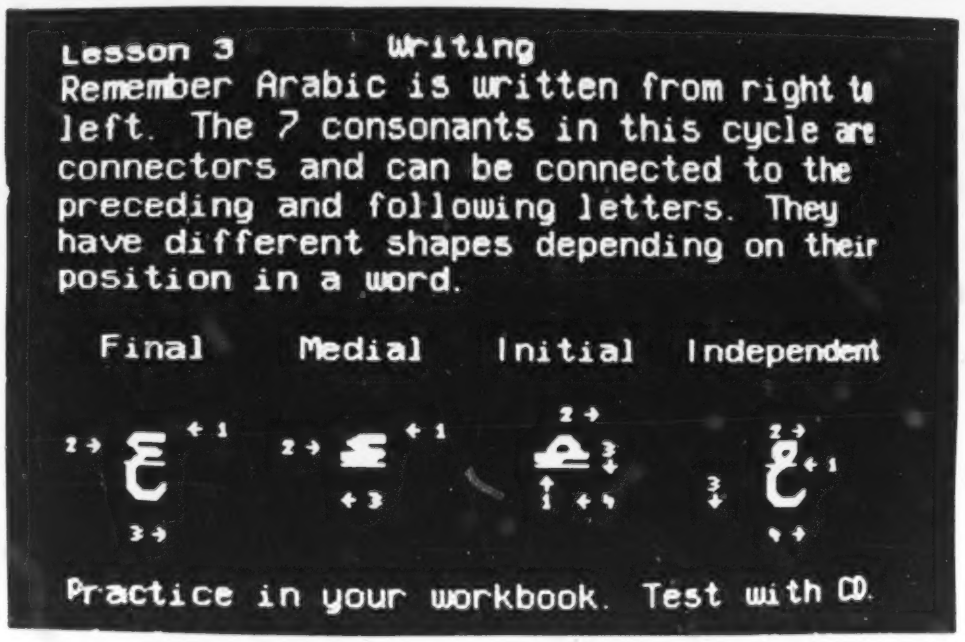
Lesson 3 Writing
Remember Arabic is written from right to left. The 7 consonants in this cycle are connectors and can be connected to the preceding and following letters. They have different shapes depending on their position in a word.
Final
Medial
Initial
Independent
Practice in your workbook. Test with CD.

Figure 8a

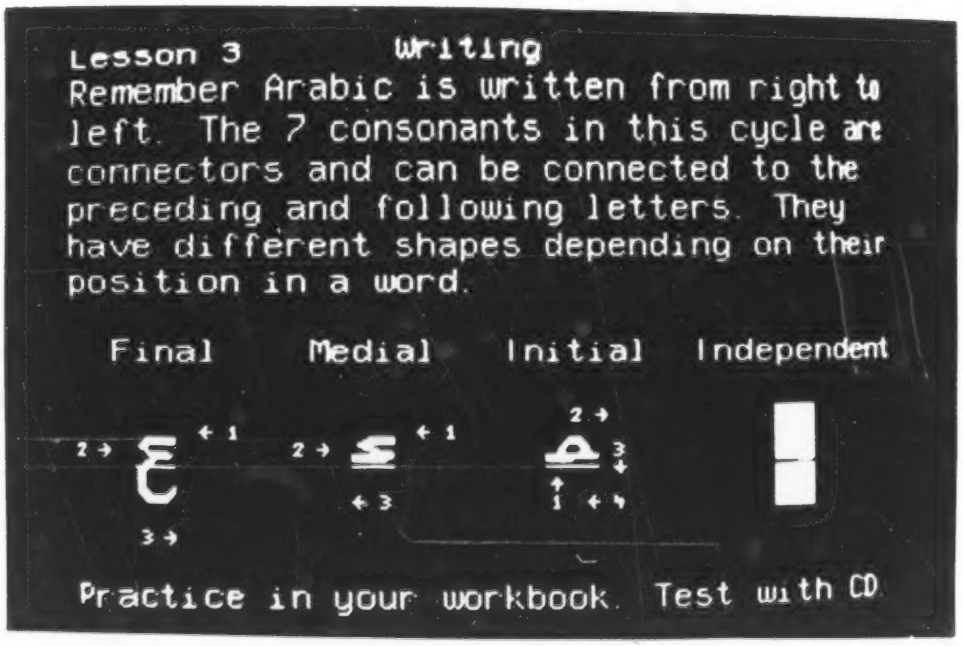
Lesson 3 Writing
Remember Arabic is written from right to left. The 7 consonants in this cycle are connectors and can be connected to the preceding and following letters. They have different shapes depending on their position in a word.
Final
Medial
Initial
Independent
Practice in your workbook. Test with CD.

Figure 8b

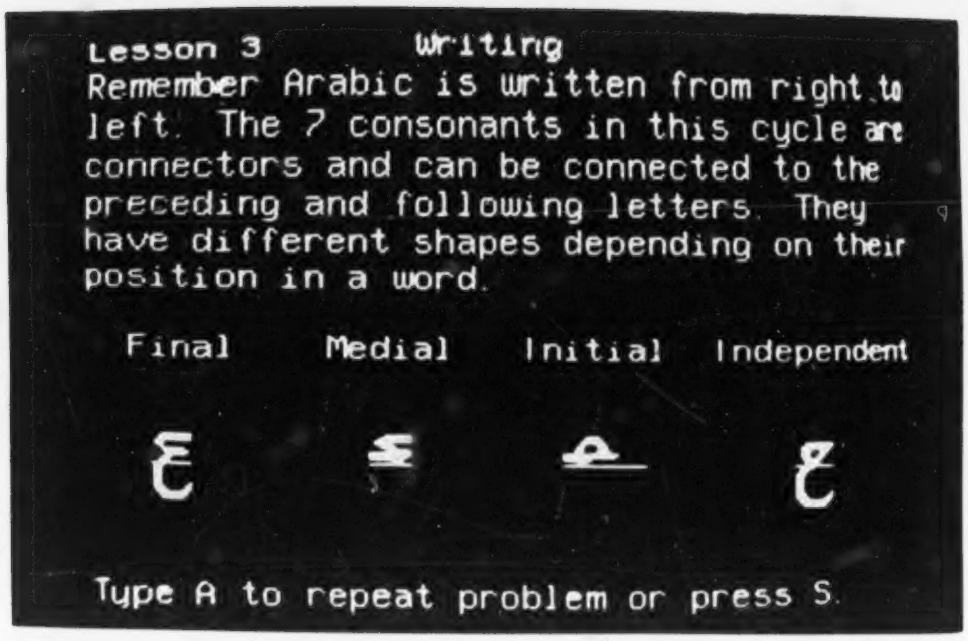
Lesson 3 Writing
Remember Arabic is written from right to left. The 7 consonants in this cycle are connectors and can be connected to the preceding and following letters. They have different shapes depending on their position in a word.
Final
Medial
Initial
Independent
Type A to repeat problem or press S.

Figure 8c

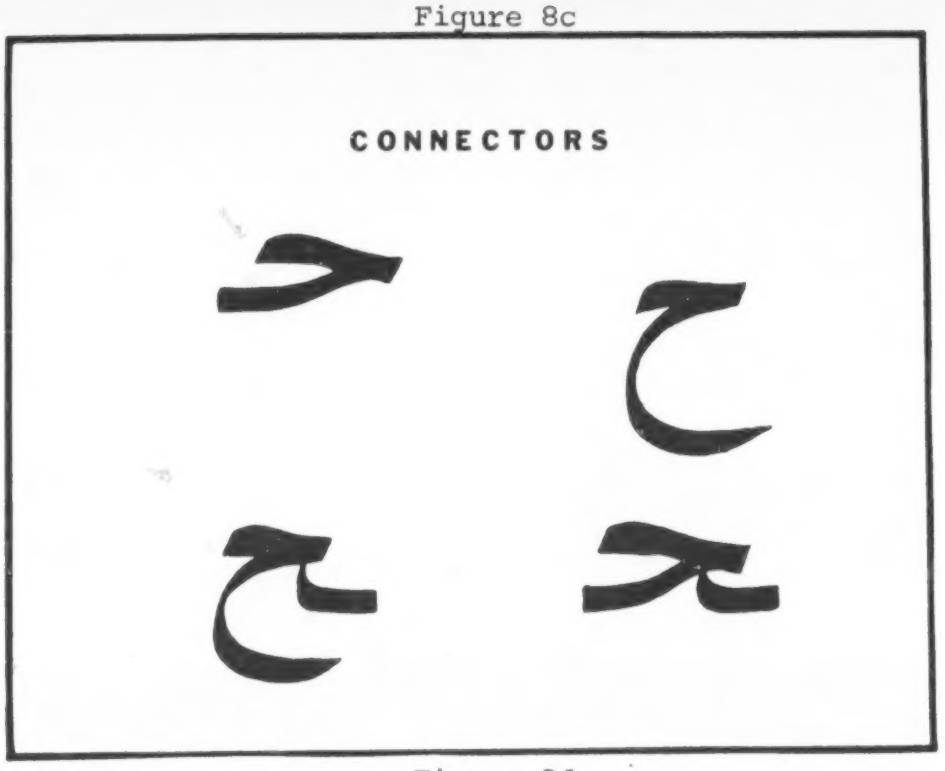

Figure 8d

To give the student immediate feedback, a procedure has been found by which the student will be able to correct his own work. After the letter has been displayed with lines, arrows, and numbers, the student is asked to practice writing it in his workbook. When he is ready, he can press the space bar, and the letter will disappear with its arrows and numbers, and a white square with a black line will appear on the CRT. The student can then write the letter with a special pen on the face of the screen; then, by again pressing the space bar, the student can have the letter reappear on the screen through his own letter. He can thus compare his letter with the correct form

(this procedure will be abbreviated by CD, Compare Display). This is the first time such a procedure has been used in a CAI program, and it will be used in practicing and correcting words formed of many letters, also. The student can repeat this step as often as he feels the need for it. In this work the classroom teacher will, of course, drill and test the students' ability to write the letters correctly. When all new letters and their different forms have been displayed and practiced, the student is given a display of all the letters on the CRT. This will help the student to see them in relationship to each other.

The same letters will also be displayed on the IP. Colors have been used on the IP to emphasize the different types of letters and their different forms. *Green* is used for all non-connectors (they do not change their shapes). *Blue* is used to show the *independent* forms of connectors, and *pink* is used to show the connected forms of connectors. Colors will be used for the first few exercises in each cycle, but they will be withdrawn later in the cycle.

Objective 4: Given Independent Forms of Cursive Letters, Write and Discriminate Correct Forms of Words. Many exercises and drills will be given to ensure enough practice in writing correctly. Each letter will be given in all its forms and exercises showing the use of the various forms will be given. The student will also be able to correct his own work (CD).

Three or four letters in their independent forms will be displayed on the CRT. The student will try to join them correctly. He can then press the space bar to get the correct form. He is then asked to practice writing it in his workbook. When ready, he can press the space bar again, and this time, the word will disappear. In its place, a white square with a black line will appear. He can then test his ability in writing the word correctly by writing it with the special pen on the screen in the square provided. For comparison and correction, he can recall the correct form (which will appear behind or through his own form). He can thus get immediate feedback and satisfaction. Again, it is important to stress that as this program is to be given in conjunction with classroom instruction, the teacher will be the person to make sure that the student can write correctly by testing him in class. (Arrows and numbers are completely withdrawn. Figure 9a shows arrow--student to request response; Figure 9b shows response given; Figure 9c shows white square for student to write in; Figure 9d shows comparison of display; and Figure 9e shows the full representation on the IP.)

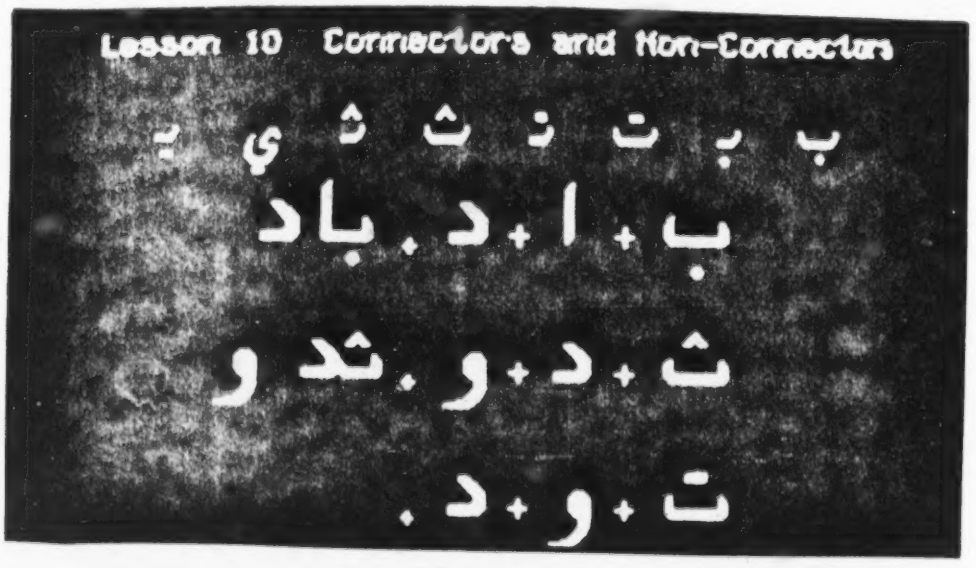

Figure 9a

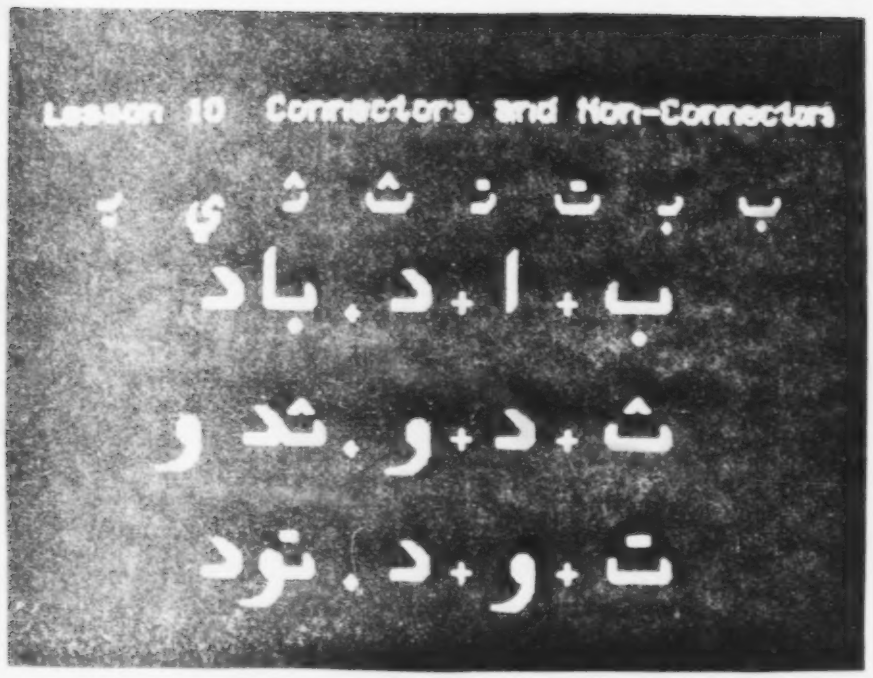

Figure 9b

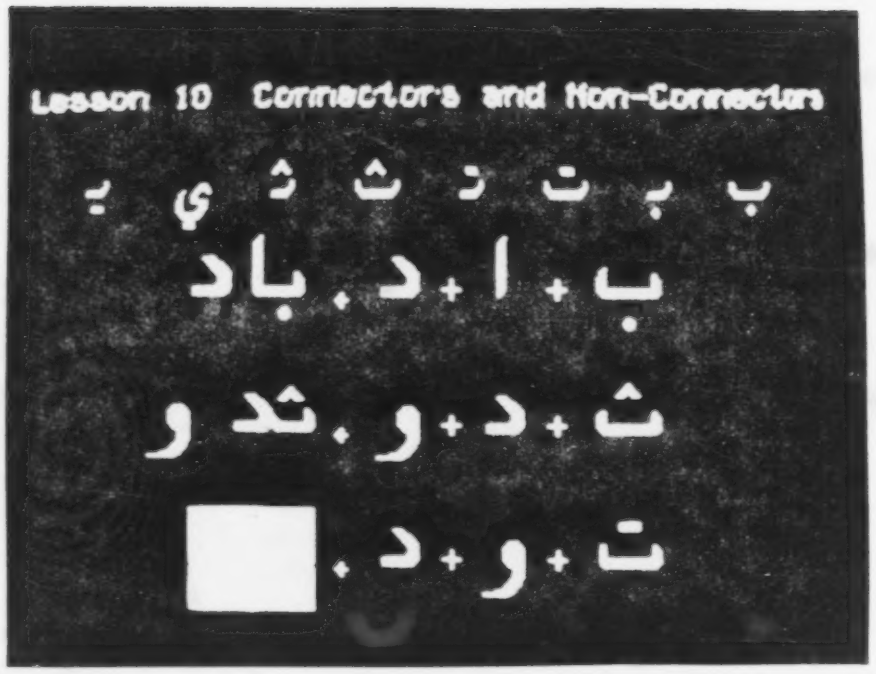

Figure 9c

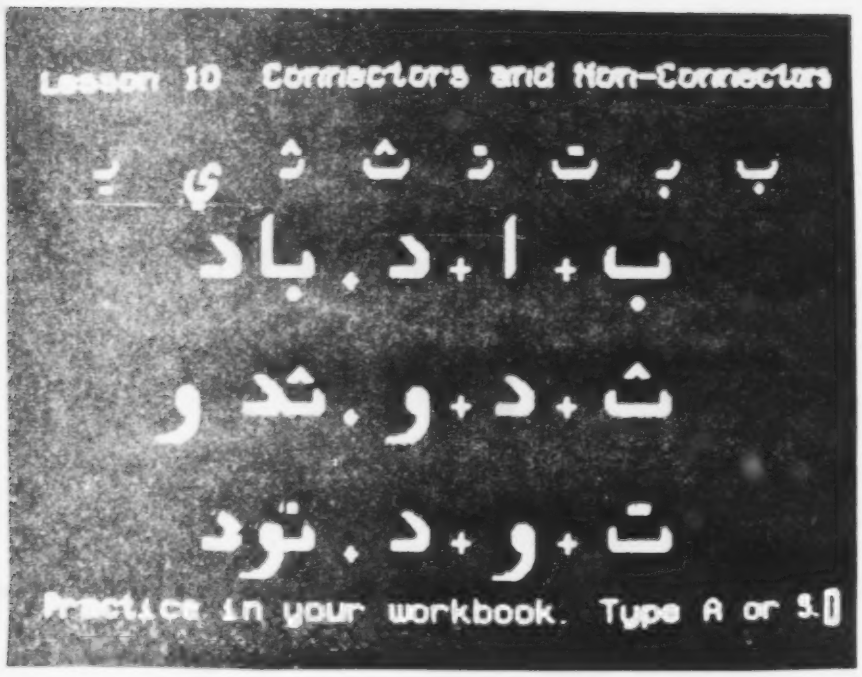

Figure 9d

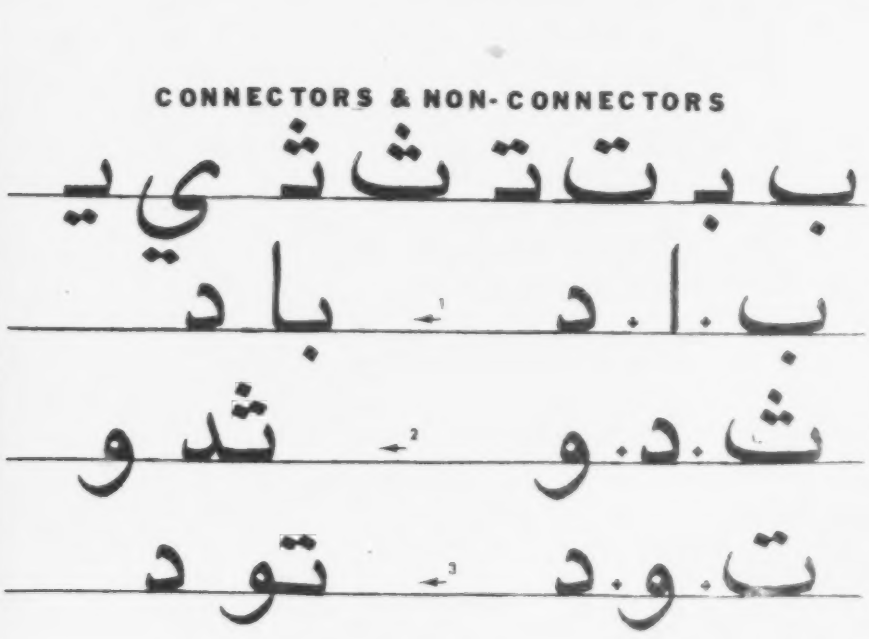

Figure 9e

A self-evaluation test is then given. Three or four letters are given on the CRT. Three words are then displayed, and the student is asked to push his light pen on the correct form. If correct, he gets a confirmation, but if he gets a wrong answer, a hint is given as to why his answer is wrong. If he makes any mistakes, he must repeat the test; otherwise, he goes on to the next test (Figure 10 shows the self-evaluation test).

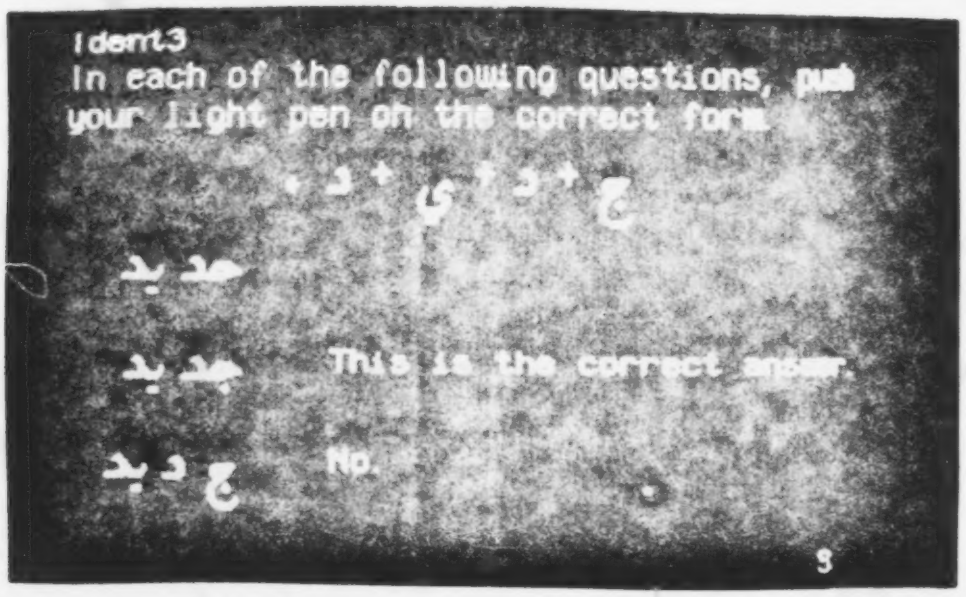

Figure 10

The next test is for the purpose of grading. If the student gets less than 90% correct, he is branched to review and is then asked to repeat the test. In this test, the student is only informed as to whether he is correct or wrong, and he is also informed how many answers were incorrect (Figure 11 shows the test for grading).

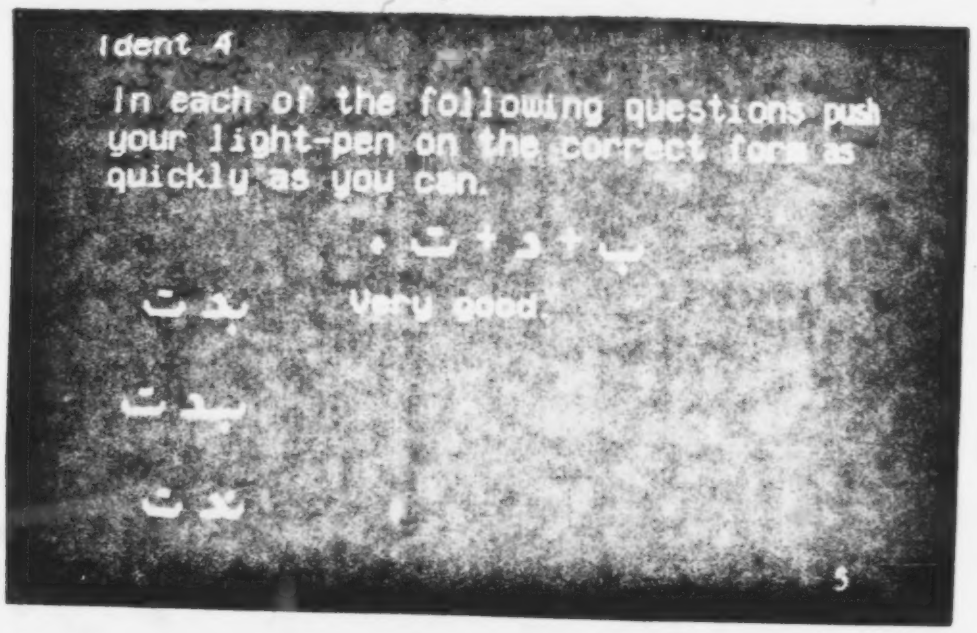

Figure 11

Objective 5: Write and Discriminate Words in Cursive and Printed Forms--to Read with Diacritics. Diacritics (auxiliary signs) can represent various things in the Arabic writing system: short vowels, doubling of consonants, no vowel, etc. In each cycle some diacritics are introduced. The students are introduced to short and long vowel contrasts by hearing words on tape and seeing them displayed on the CRT. When more diacritics have been introduced in the following cycles, the student is given words with diacritics and is asked to read them. When ready, he can request to hear them read on tape. He can repeat such a process as often as he wants. The student is next given the same kind of exercises for writing words, but those will include diacritics. The IP will also show the printed form of such exercises. The CD operation can be repeated for every word. The student is also encouraged to try to read the words in the exercises he is writing. (Figure 12a shows writing exercise; Figure 12b asks the students to read; Figure 12c shows the printed form.)

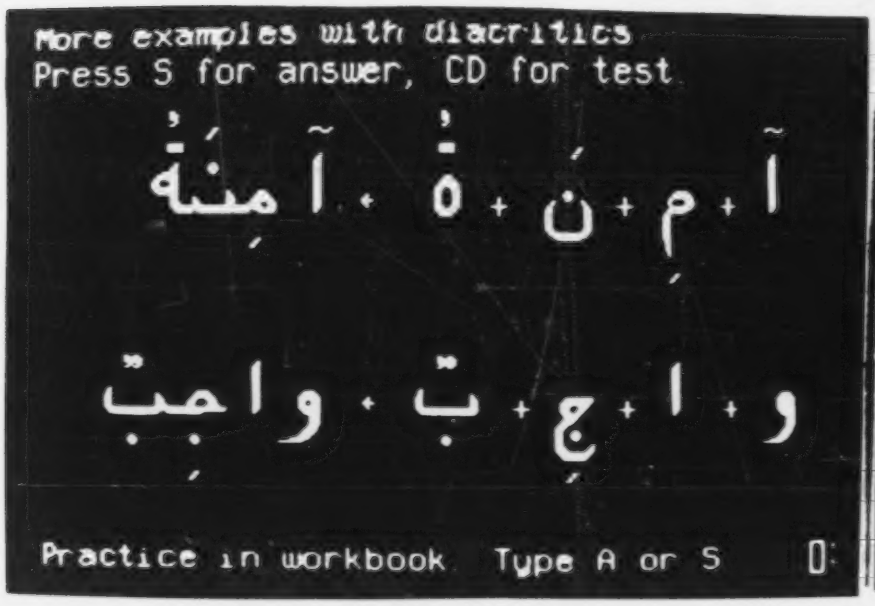

Figure 12a

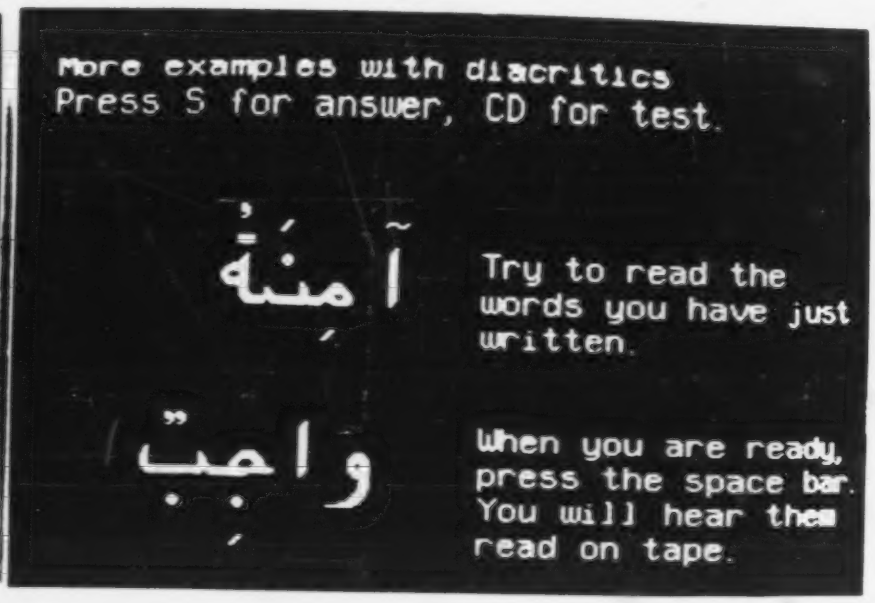
More examples with diacritics
Press S for answer, CD for test.
Try to read the words you have just written.
When you are ready, press the space bar. You will hear them read on tape.

Figure 12b

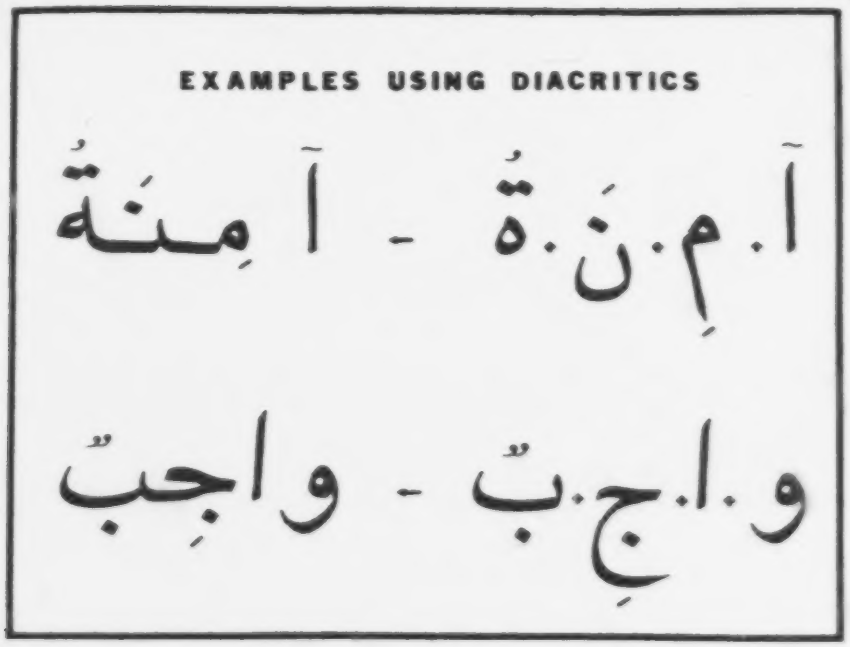

Figure 12c

A test is now given in which the student has to hear a word read on tape and then chooses the right form of the word from two or three words displayed on the CRT. This test is for the purpose of grading. If the student has less than 90%, he is informed how many answers he had correct and is branched to a review; he must then repeat the test. If he has 90% or more of his answers correct, he goes on to the last test (Figure 13 is a test using audio messages).

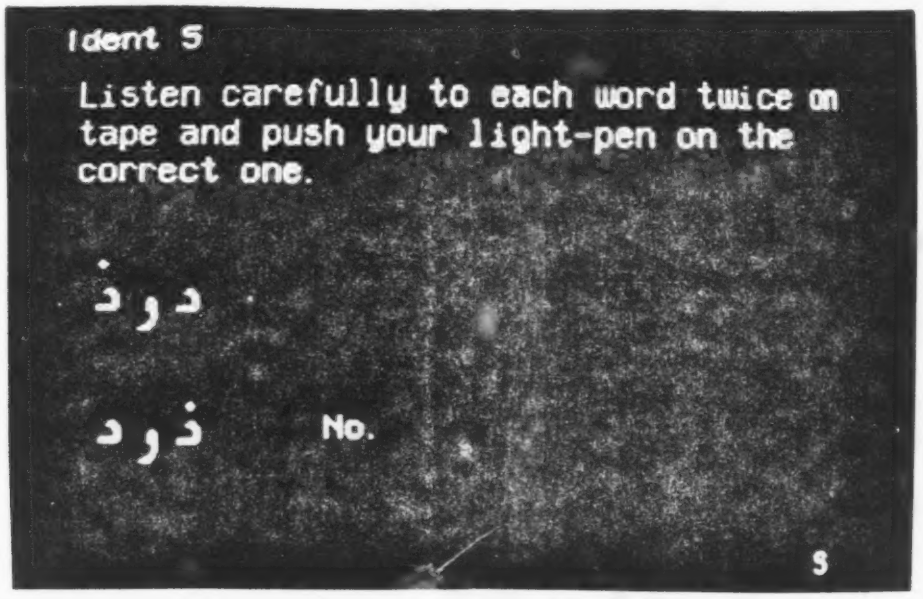

Figure 13

This test will be a dictation of a certain number of words. When the student has finished the test by writing in his notebook the words he heard on tape, he can press the space bar,and the dictation will be displayed on the CRT and IP (no colors). This again is for self-evaluation. The teacher will give a dictation in class to make sure the students have reached the objectives of the CAI in the Arabic writing system. (Figures 14a and 14b show dictation in cursive form; Figures 15a and 15b show the Arabic letters in their alphabetical order in the cursive form; and Figures 15c and 15d show them in their printed form.)

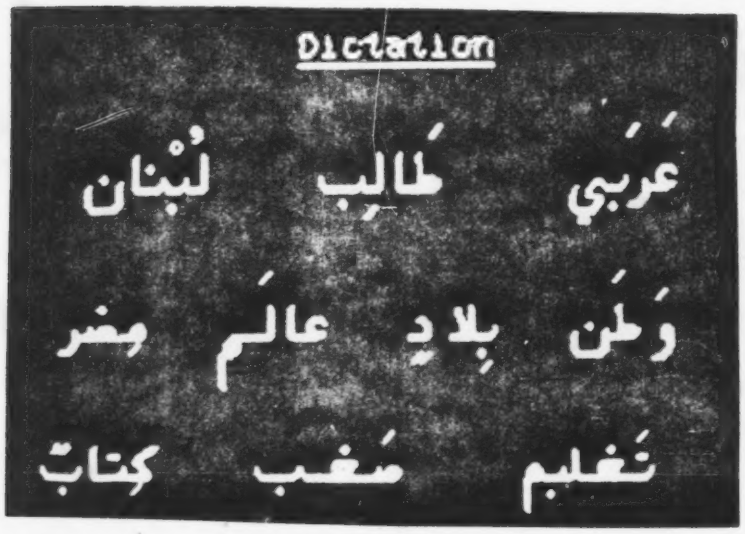

Figure 14a

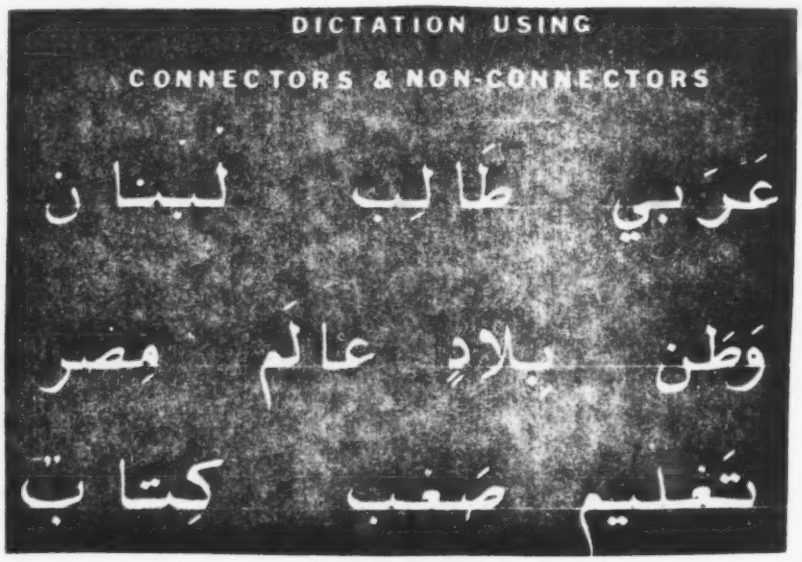

Figure 14b

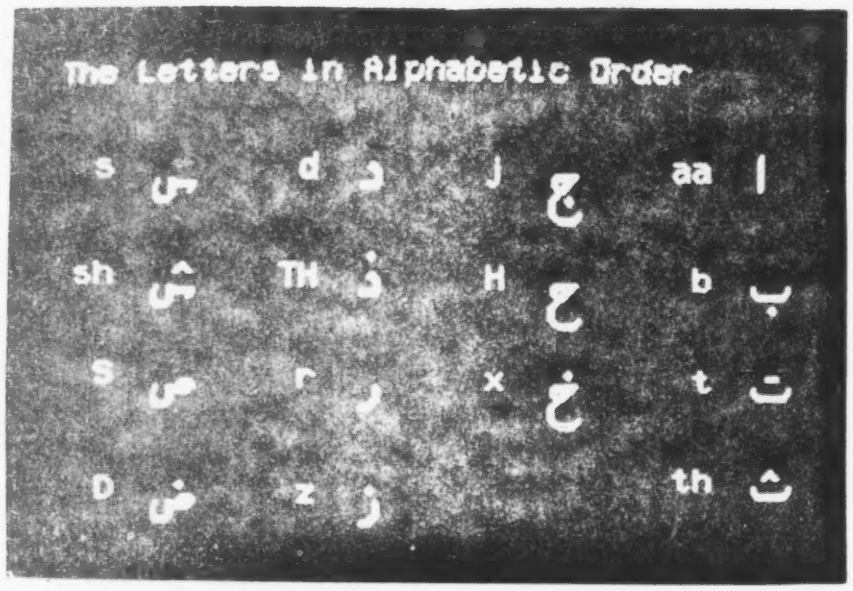

Figure 15a

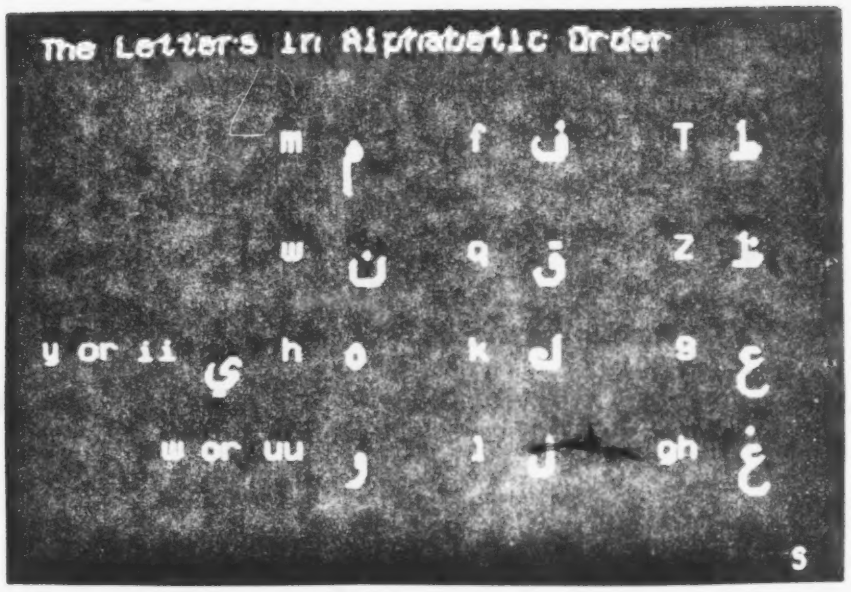

Figure 15b

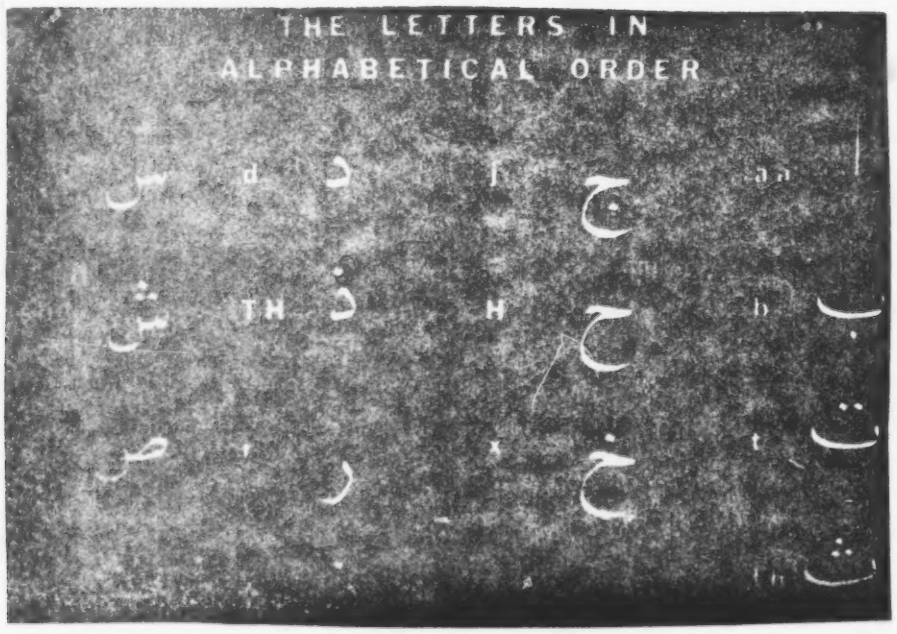

Figure 15c

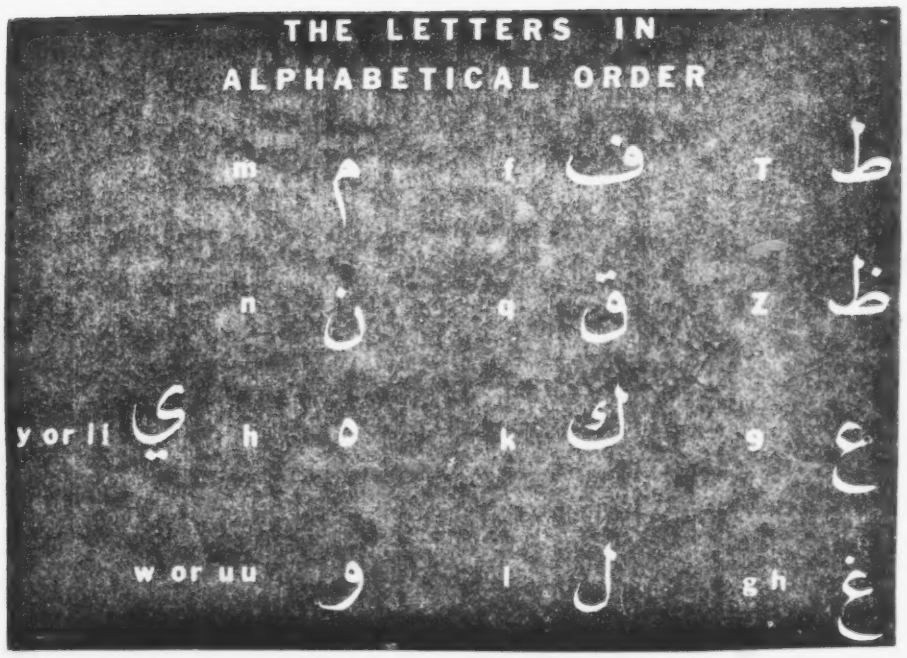

Figure 15d

Flowcharts

Flowcharts are a means of presenting information and operations so that they are easy to visualize and to follow. They show the flow of data through an information-processing system, the operations performed in the system, and the sequence in which they are performed. The major patterns of individualizations described in the flowcharts are based on the learning hierarchy (Figure 1).[22]

One of the most important uses of a program flowchart is to provide the programmer with a means of visualizing, during the development of the program, the relationship of one portion of the program to another and to show the multiple parts which students can take during a course.

The following three flowcharts will be given for this program:

Flowchart 1: This will show the overall mainline logic and will indicate the path a student will take if successful at all points, with no request for individualization (Figure 16).

Flowchart 2: This will show the logic by which the student will be branched by author-specified criterion to certain points in the flowchart (Figure 17).

Flowchart 3: This will show how, at the student's request, individualization can occur for repetition of one single item in a lesson or for the whole lesson (Figure 18).

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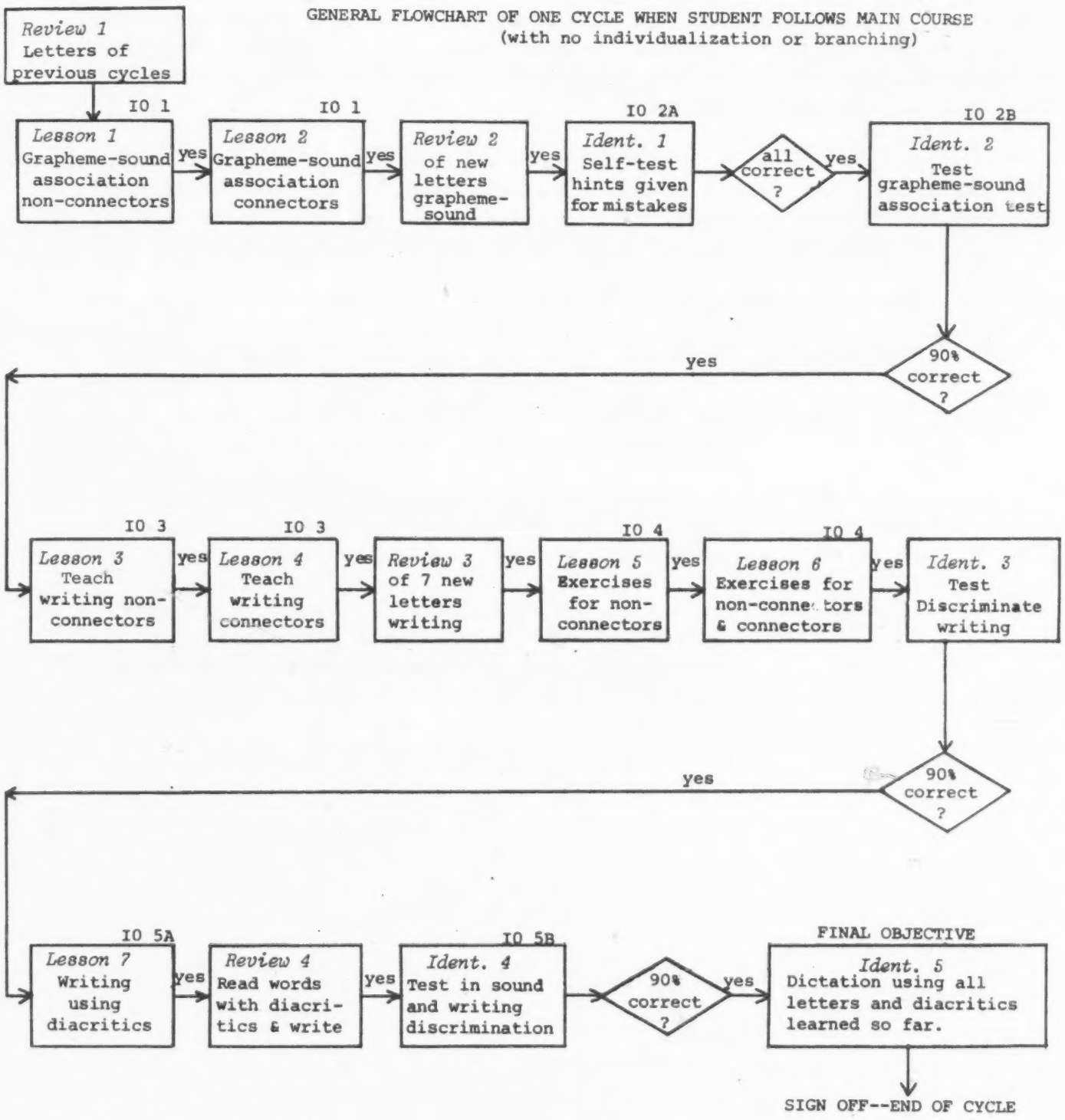
[22]Some of the information is from IBM Flowcharting Techniques (Data Processing Techniques).

FIGURE 16

GENERAL FLOWCHART OF ONE CYCLE WHEN STUDENT FOLLOWS MAIN COURSE
(with no individualization or branching)

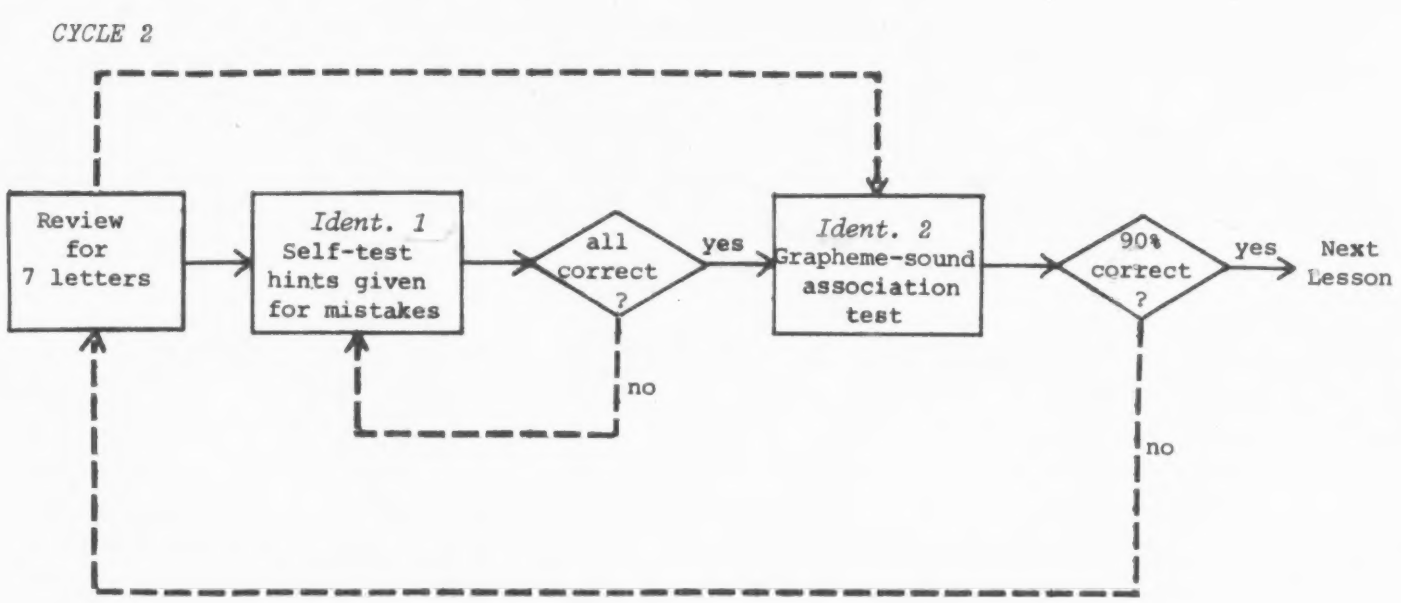


Decision Boxes = ◇

Follows Learning Hierarchy
Intermediate Objectives (IO)

FIGURE 17

BRANCHING CAPABILITIES OF COMPUTERS UNDER CERTAIN SPECIFICATIONS GIVEN BY AUTHOR



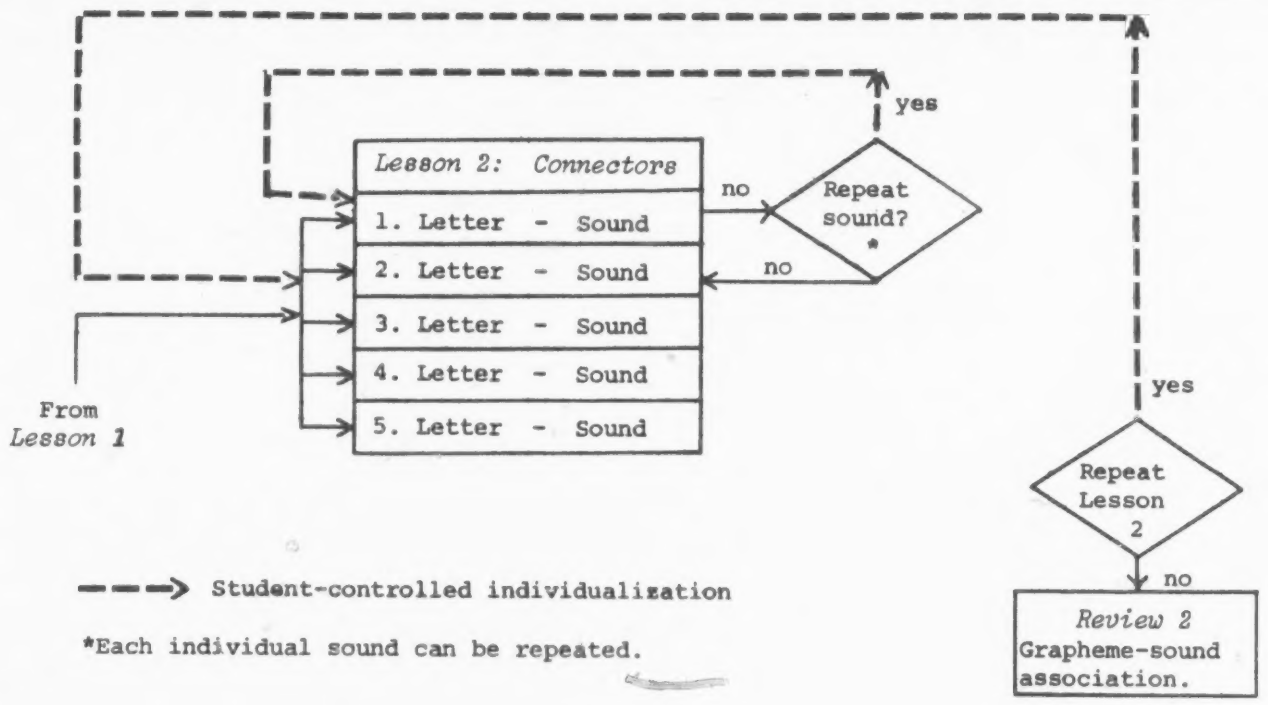


FIGURE 18

INDIVIDUALIZATION UNDER STUDENT CONTROL
(This Can Occur in Every Lesson)

C H A P T E R IV

AUTHORING AND PRODUCTION PROCEDURES

In Chapter II, the design of the *systems architecture* of this CAI program in the Arabic writing system was formalized. The decisions made in analysis and synthesis of the structure and conventions of the program guided the author in producing the actual program steps which the student would see, the format of these steps, and the manner in which they were to be linked together. The *author's draft* describes and documents these steps.

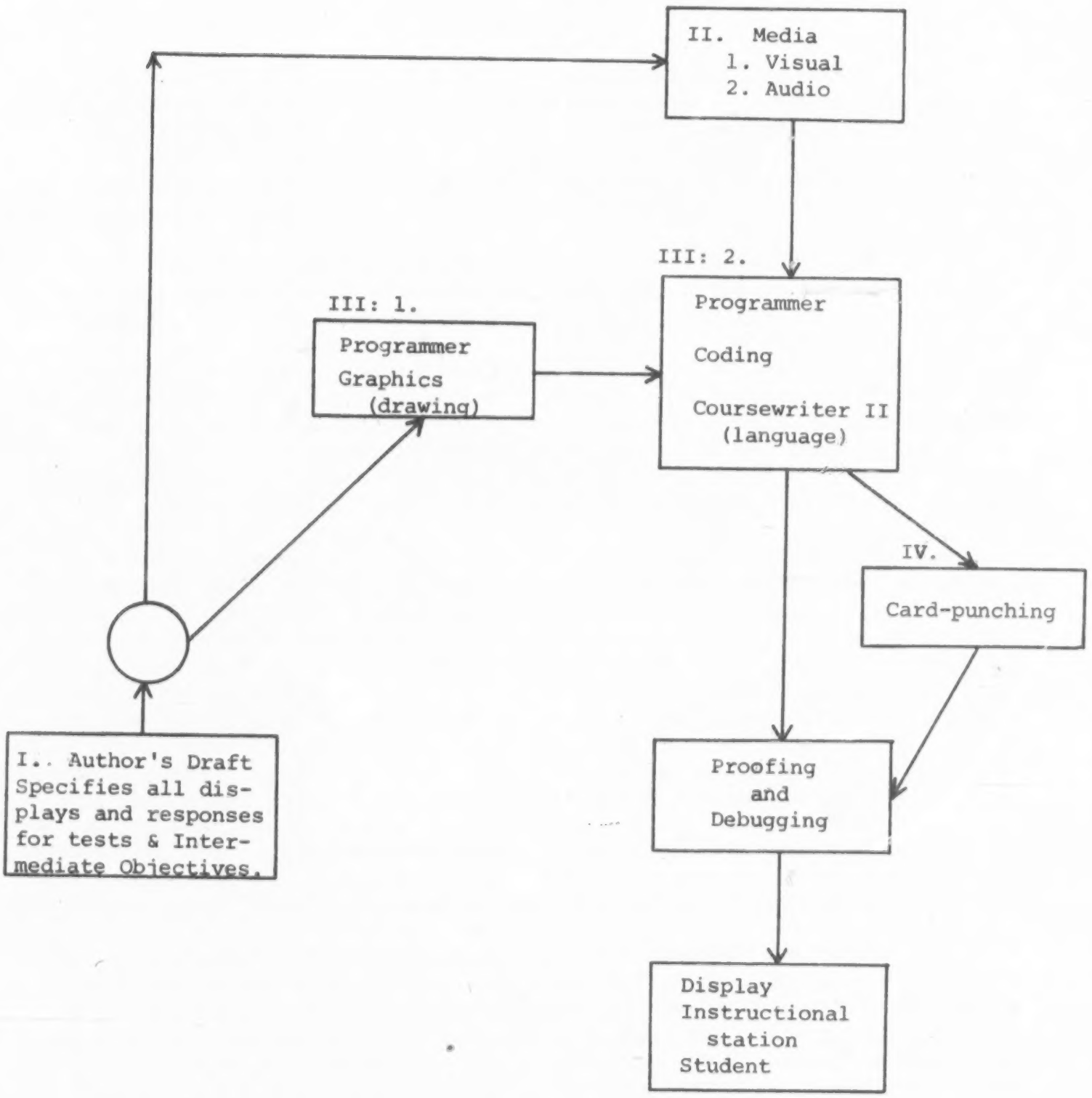
Each intermediate objective which was developed by analysis of the terminal goal enables the author to determine what word would be displayed to the student and how he must perform when he sees certain displays if he is to demonstrate that he has learned the objective. Thus, the display and response conventions for each objective can be determined. These decisions regarding display and response conventions are of enormous importance to the author when he sits down to write instructional frames, for they limit the complex decisions he must make in a constructive and helpful way. They also specify at a first level of approximation the work that media specialists and graphics programmers must perform in producing the program.

The intermediate objectives also form a hierarchy, and this hierarchy provides a first approximation to the sequence which the program will follow. Since each objective is a performance objective, it is a *recipe* for writing test items which can be used to determine when a student is ready to go on to the next level in the hierarchy. As discussed in the previous chapter, these test items form an important basis for individualization, which is described by means of flowcharts. For the purposes of the author's draft, the extent to which the objectives, hierarchy, and flow charts help the author in writing his test items cannot be overemphasized, for these not only provide him with "recipes" for writing items, but give him a full understanding of why the tests are necessary and how they will be used to provide individualization. When the test items have been written, the author's draft has begun to take shape, and indeed actually represents a "lean program" which can be used with students to guide further development.

Authoring material for a CAI program is very different from any other form of documentation for the production of textbooks or workbook materials, lectures, or even programmed instruction. A CAI program is a teaching system where the student's response often determines the sequence of frames or lessons. The author of a CAI program must be very specific in his instructions, as to the type of media to be used, and his language must be precise, complete, and accurate so that all possible student responses

FIGURE 19

FROM *AUTHOR'S DRAFT* TO *INSTRUCTIONAL DISPLAY* TO *STUDENT*



will be followed by an instructionally relevant rejoinder from the program. It could be compared to the task of writing a dialogue script for a play, except that the replies of one of the actors cannot be specified completely and must therefore be anticipated, and a whole set of short alternate scripts prepared for the actor playing the part of the tutor for each contingency. It is, therefore, of utmost importance that an author's draft or "CAI manuscript" be prepared with great care.

Author's Draft

The preparation of an author's draft must use a formal and consistent format as the author must be able to communicate his system, requirements, and specifications to media specialists, other authors, or other institutions that may want to use that CAI program. The steps of CAI course production and how they depend on the author's draft are shown in Figure 19.

The author has to plan very carefully how many frames will be presented, how many tests must be given, what sort of media must be used for the specific task, and how best to present his material to achieve optimal success. The language by which he must communicate his concepts, instructions, and thoughts must be precise but not at the cost of being abrupt or rude. As the CRT has specific dimensions, number of lines, and number of letters on each line, the author must also find a way to allow the student to finish a task without having to wait for the whole screen to be erased. Thus, he may find that the use of "overlays" will reduce repetition of instruction.

Another aspect of the author's work is to find where to display certain graphics on the screen and how many of them to display at the same time, as crowding might delay the learning required. The task is made easier by the use of IBM Display Planning Guides. These planning charts show 40 columns and 32 rows. Each column and each row is addressable so that the user can display information anywhere on the screen by giving row and column address. All these tasks are very exacting and time consuming but necessary for the success of any program. In trying to present Arabic graphics on the CRT, a frame sometimes had to be rewritten many times before achieving the neat exact form which will enhance the learning process. A display of instructions for sound identification is given in Figure 20a. Consonants are displayed one at a time. As the same instructions apply for vowels, an overlay is used. Figure 20b retains all the previous instructions and only changes from consonants to vowels, displaying the vowels one at a time. The overlay techniques can also be seen in Figures 21a and 21b. Figure 21a gives examples for writing exercises to show the students how to join letters together. When the student is ready, the individual letters disappear and the words are left on the screen. The student is then asked to read these words; this is shown by the overlay of Figure 21b.

Figure 20a

IBM

IBM 1510 Instructional Display Planning Guide

Form X26-5608-0 (U/M 025)
Printed in U.S.A.

(To observe overlay effect in author's manuscript,
please clip on dotted line.)

Column

Row
Half Line

Lesson 2 Identification audio.

In this cycle you will learn five consonants and three long vowels. Listen carefully to the tape and look on the CRT to the corresponding letters. Each sound will be repeated twice. Try to mimic the sound. After a pause you will hear it a third time.

English Vowels Arabic

ii

ii as in tin

Practice in your workbook. Type A if you want this repeated. Press the space-bar to continue.

OVERLAY

Figure 20b

Column

Row
Half line

Lesson 2 Identification audio

In this cycle you will learn five consonants and three long vowels. Listen carefully to the tape and look on the CRT to the corresponding letters. Each sound will be repeated twice. Try to mimic the sound. After a pause you will hear it a third time.

English Consonants Arabic

b ب b as in book

Practice in your workbook. Type A if you want to see the letter and hear the sound again. Press the space-bar to continue.

Figure 21a

IBM **IBM 1510 Instructional Display Planning Guide**

Form X26-5608-0 (U/M 025)
Printed in U.S.A.

OVERLAY

Column

Lesson 5 Read the words you have written

Row
Half line

عالَمٌ

رُجوع

When you are ready press the space-bar You will hear the words on the tape. If you want to hear the words again, type A. Press the space bar to go on.

Pratice these words in your workbook. Press the space-bar for comparison of display. Type A if you want to repeat this lesson or S to continue.

(To observe overlay effect in author's manuscript, please clip on dotted line.)

Figure 21b

IBM **IBM 1510 Instructional Display Planning Guide**

Form X26-5608 0 (U/M 025)
Printed in U.S.A.

Lecsson 8 Writing

Write the following words:

جُ + ع + ا + د ⟵ جُعاد

عَ + ا + لَ + مٌ ⟵ عالَمٌ

رُ + ج + و + ع ⟵ رُجوع

Pratice these words in your workbook. Press the space-bar for comparison of display. Type A if you want to repeat this lesson or S to continue.

When the author has finished his author's draft and has decided exactly what graphics to display, where and when audio messages are to be relayed, when a light-pen is to be used, or an answer typed, he will then go to the next important step, which is that of testing.

As each cycle was finished, high-school and college students (five high-school and five college students) were tested with the author's drafts simulating the computer situation. The students were asked to go through the author's draft, and the author provided the audio messages when they were needed. As the student finished each frame he gave a signal, and the author then showed the new frame. When a light-pen was to be used, the student was asked to underline the word chosen. This was found very useful, as the author was able to make many changes in the cycles. The changes were made either because of the number of mistakes the students made on a specific question or because of ambiguities which the students pointed out, or because suggestions of improvements were offered.

The author's draft is the means of communicating to all personnel involved in the production of the program. It must be written according to conventions which can be communicated to coders and media specialists to work from in order to produce filmstrips, audio tapes, and printed material to accompany digital code. Branching conditions must also be clearly specified for remedial and review exercises. The author's draft is the only document for coding and for media specialists and must therefore be written with great care and exactitude.

Media Specialists

A. Visual. Although most of the CAI program for the Arabic writing system (cursive form) was displayed on the CRT, it was found that there was the need for the use of the IP for the printed from of the Arabic script. By providing the students with both the cursive and printed forms of the frames, the association between the two forms would be greatly facilitated. This simultaneous representation of the cursive and printed forms has not been given before in any other program. The CRT and IP make it possible.

> The IBM 1512 IP holds a display screen 9 in. x 7 in. on which color or black-and-white images can be projected from a 16 millimeter film. The film is automatically threaded by the projector unit and can show as many as 1,000 different images in sequence as directed by the course author in his course presentation program or author's draft. Each image has a unique address which is verified as the desired address before the shutter is opened to reveal the picture.

The use of color on the IP allows the author to emphasize the concept of connectors versus non-connectors as well as connectors in independent versus connectors in their connected forms. *Green* was used for non-connectors (they never change their shape), *blue* for connectors in independent form, and *pink* for connectors in their connected forms.

The author had to prepare 70 master cards of the exact size of the IP display area to show the printed form of the letters which had to be displayed on each individual frame. Figure 22 is an example of a master card. Such a task was impossible for the media specialist as it was a foreign language to her (although the drawings of the diacritics, arrows, and lines prepared by the specialist were done in a very efficient manner). When the master cards or layouts were completed, 8 in. x 10 in. negatives were then produced. If the masters met the author's requirements, they were then photographed. A reversal copy (or negative) was then made. The negatives have clear letters or symbols on a black background.

DICTATION USING

CONNECTORS & NON-CONNECTORS

خِلاف حَديث جَديد

شَهْرٌ هَيكَلْ كَبير تَقَدُّم

جَنيب كِتاب خُروج

Figure 22

With every master layout, the author provided the media specialist with a duplicate in which colors were specified. Photographer's gel of the different colors required was then taped according to the author's specifications. This was a time-consuming and exacting job for the media specialist. The color negatives were then aligned by the use of an Acme field chart.

A precoded film was used to eliminate the editing of the film. The addresses of the different frames were then given to the programmer or coder so that the frames could be coded at the right place in the program.

The IP was used to display four sizes of every letter of the alphabet and their different shapes; starting with a large size, the sizes of the letters gradually decreased. This gave the student the opportunity to achieve the ability to read and write different sizes gradually, which thus enabled him to write in the usual handwriting size of script.

B. Audio. Although the main goal of this CAI program is to learn how to write Arabic, it was found most advantageous for the student if the sounds of letters and words were also given. Students were also encouraged to mimic the sounds and to try to read words and to listen to them on tape.

Writing the audio course is the first operation. Each audio message is referred to by a symbolic name. By referencing messages symbolically, the author can go back and change the content of any message. During the narration process, audio messages were recorded serially on Track A through the microphone connected to Channel A of the narration transport. Simultaneously, cue tones, produced by a cue-tone generator allows the narrator to define the beginning and end of each audio message, emphasis marks, and group marks.

The script for narration was prepared by the author, with each message being accompanied by its symbolic name. The narration was introduced by the audio media specialist and the sounds of letters, words, or dictation were given by the author (who is a native speaker).

All information from the media specialist as well as the author's draft had to be coded in the language to tell the CAI system exactly what operations to perform, under what conditions to do them, which of the instructional units to use, when to perform each operation, and where the data needed in the operation is located.

Coders

To simplify the operation of coding, Coursewriter II allows the coders to use special symbolic names and characters, each of which has a clearly defined set of rules. Using these special symbols and names to implement the author's instructions is called coding or programming, and the entire collection of code for a given course is called its Coursewriter Program. Once the author's draft has been coded, it must go through a refining process called Assembly. The Coursewriter Assembler converts the various parts of Coursewriter code to an organized and complete program that can be executed by the Coursewriter Interpreter.

The Coursewriter Interpreter executes the operations that have been coded into Coursewriter Program, thus presenting the course material to the student or to an author who is testing the coding.

Coders must learn the language of Coursewriter so that they know what can be done in the way of presenting instructions to students. The program must be coded in this particular form so that the Coursewriter Assembler can process it.

A Coursewriter II Instruction Sheet is provided for the coder to use to format the statements in the course. Each course statement or instruction consists of the following parts:

(1) *Label:* The label consists of from one to six alphanumerical characters. It is used as an entry into the course and allows unique identification of a course statement.

(2) *Operation Code:* The operation code is required in each instruction and consists of two lowercase alphabetic characters which define the action to be performed on the next part of the course statement. Some of these codes are listed below:

Operation Code	*Action*
dt	Display Text
ca	Correct Answer
wa	Wrong Answer
un	Unrecognized Answer
dg	Display Graphics
dl	Display Emphasis Line
au	Audio
fp	Position Film
br	Branch to a Label

Figure 23 is one page of coding from this CAI program.

IBM

IBM 1500 Operating System, Computer Assisted Instruction
Coursewriter II Instruction Sheet

Course Name Arwri
Author's Name Suzanne Evans

Date: April 7, 1970
Page No. 10 of C3

Label	Op Code	Modifier	Blank	Parameters	Cont. Code	I.D. & Seq. Nos.
C3L2I2≠						
	PR≠					
	DE			0ⓞ/32≠		
	DT			0, 0ⓞ/ⓞ/ⓞ/<I>DENT 2≠		
	DT			2, 0ⓞ/ⓞ/ⓞ/<Y>ØU WILL HAVE LETTERS DISPLAYED ØN THE≠		
	DT			4, 0ⓞ/ⓞ/ⓞ/<CRT>. <I>N EACH QUESTIØN THREE LETTERS WILL≠		
	DT			6, 0ⓞ/ⓞ/ⓞ/BE GIVEN. <P>USH YØUR LIGHT PEN ØN THE≠		
	DT			8, 0ⓞ/ⓞ/ⓞ/LETTER WHICH CØRRESPØNDS TØ THE SØUNDS≠		
	DT			10, 0ⓞ/ⓞ/ⓞ/YØU WILL HEAR TWICE ØN TAPE.≠		
	DG			16, 5ⓞ/29, 27≠		
	DTJ			15, 8ⓞ/2, 15ⓞ/1, 8ⓞ/$10W≠		
	DG			16, 19ⓞ/31, 30≠		
	DG			16, 31ⓞ/10, 17≠		
	DTJ			16, 33ⓞ/2, 16ⓞ/2, 33ⓞ/$11.(≠		
	EPP			2140≠		
	CM			ØIX≠		
	CAP			6, 16, 4, 19≠		
	AD			1ⓞ/C2≠		
	DT			28, 19ⓞ/2, 28ⓞ/, 19ⓞ/<V>ERY GØØD.≠		
	WAP			6, 16, 4, 5≠		
	DT			28, 5ⓞ/2, 28ⓞ/, 5ⓞ/<W>RØNG.≠		
	BR			PR2≠		
	WAP			6, 16, 4, 31≠		
	DT			28, 31ⓞ/2, 28ⓞ/, 31ⓞ/<M>Ø.≠		

Figure 23

There are *op codes* for the presentation of problems, for typing and displaying instructional material, and for playing audio messages and projecting images from film reel. The response request instruction codes enter and process responses from the light-pen (the method most used in this program) and from instructional keyboards. They also control the time allowed for responses. The scorekeeping instructions permit the coder to channel into performance records the counts of a student's correct answers, wrong answers, time-outs, etc. The sequence control instructions allow the coder to provide several paths of instruction based on conditions that arise while the student is actually taking the course. Instructions of up to 123 characters in length may be entered, including the special delimiter characters but not including the label field.

Graphics

Each course may have as many as three graphic sets. Each graphic set can contain as many as 64 symbols, each of which occupies a dot area 36 dots high and 16 dots wide. Thus, a maximum of 192 symbols can be used in one frame during the execution of the course. Graphic symbols can be displayed so that several symbols make up a large composite symbol.

In addition to the system dictionary, any course can use as many as three special dictionaries designed and loaded by the author. All dictionary characters are displayed within an area of the screen which is 12 dots high and 8 dots wide. The multiple dictionary facilities makes it possible to use different sizes and styles of characters and permits the handling of special character forms required in this program.

In the CAI program of the Arabic writing system, two sizes of letters were used on the CRT. When instructions were given for practice in writing the letters, a large size of the letters was required. Figures 24 and 25 show how the large size graphics for *waaw* and *miim* were planned on the graphic coding form. Several symbols make up the composite graphics of *waaw* and *miim*.

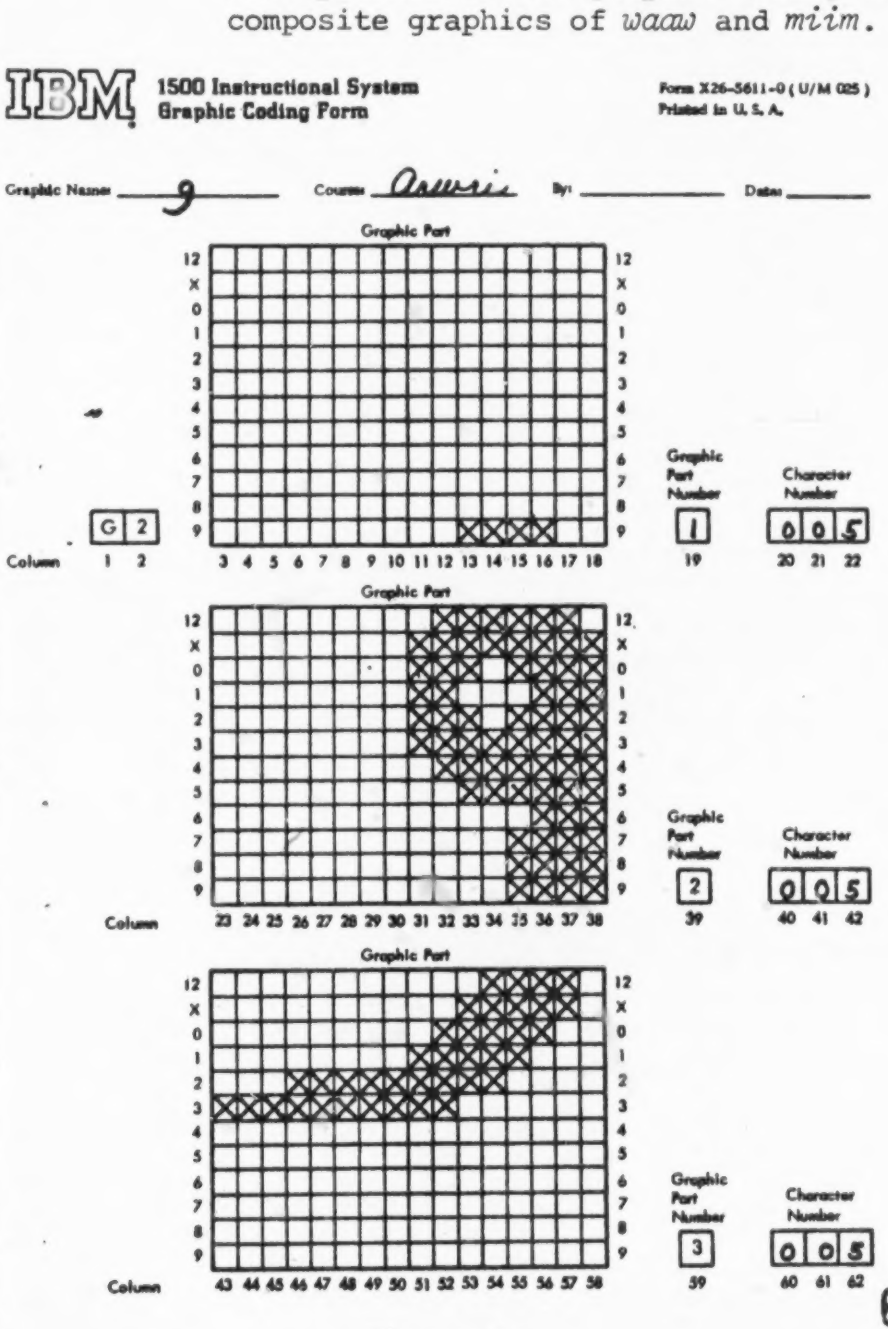


Figure 24

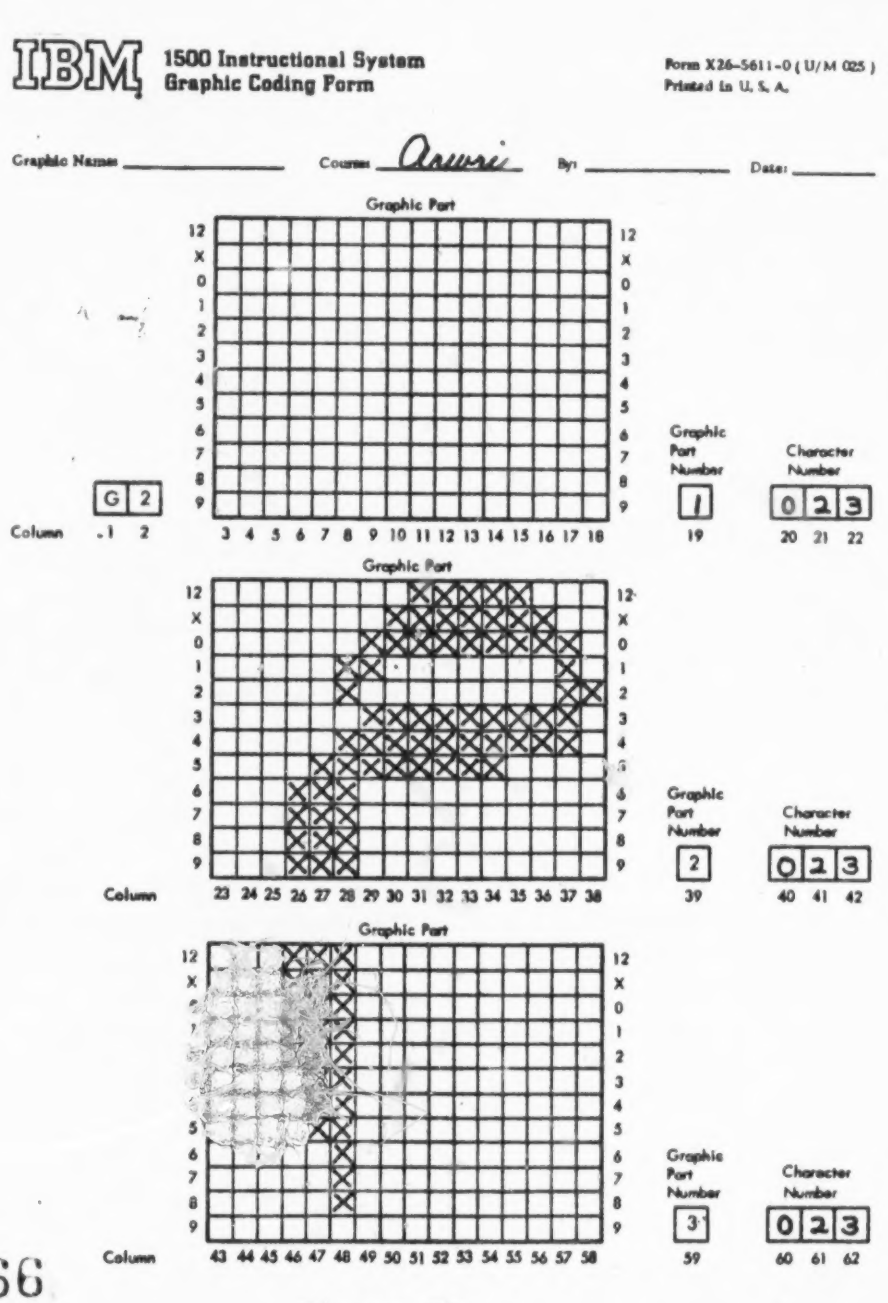


Figure 25

In tests where reading or discrimination of forms or sounds were concerned, the smaller script was displayed. Dictionary characters were used. Figure 26 shows how the dictionary characters of *waaw* and *miim* were planned.

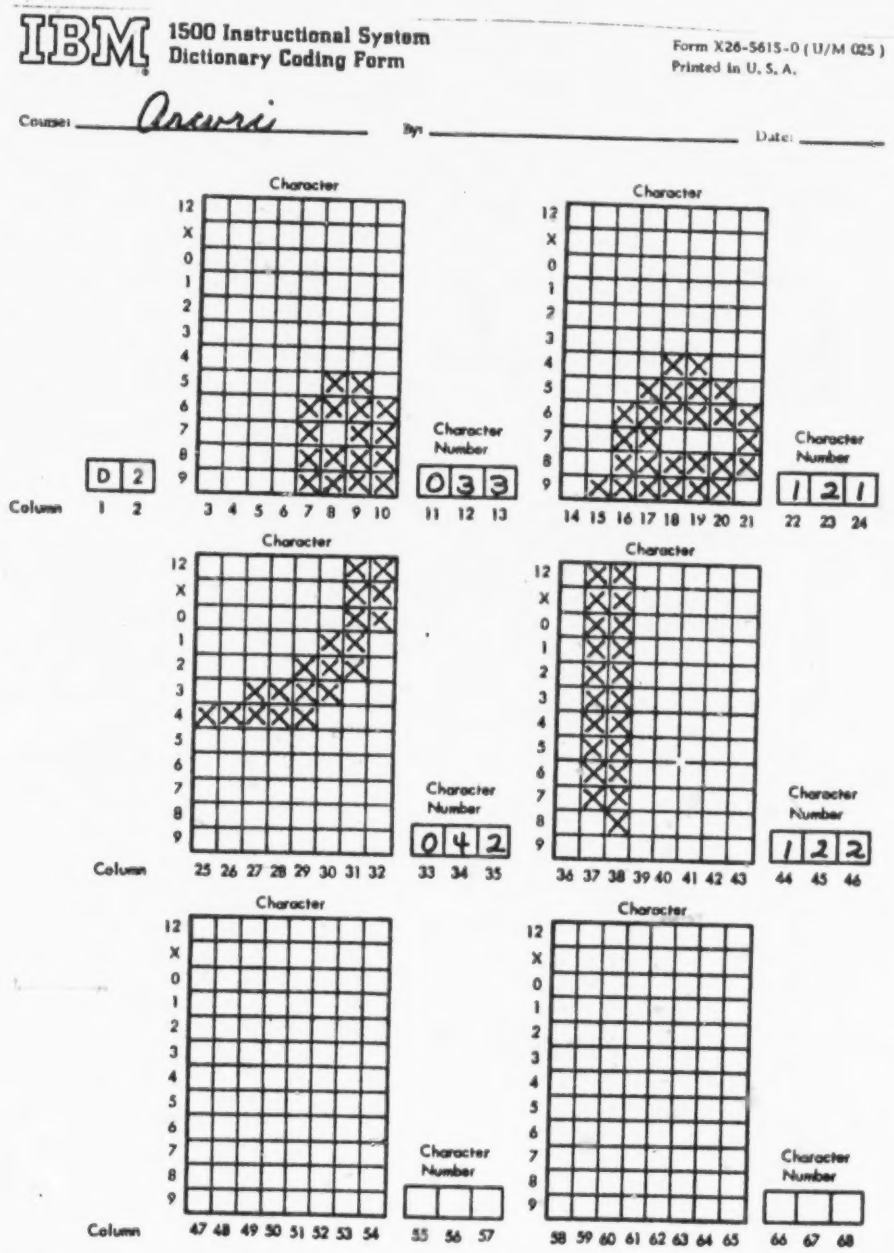


Figure 26

As there was no previous work done on any CAI program, every Arabic letter with all its forms had to be carefully drawn on IBM Instructional System Graphic Coding Forms. Many problems had to be solved. As there are 28 letters in the Arabic alphabet, 22 of which have three or four forms and six of which have two forms (see Table 1), a great number of separate graphics

would have been needed. This was not possible, as only 64 graphics could be programmed in any one Coursewriter course. Compounding this problem was the fact that any given letter could require more than one graphic. Methods were found to reduce this number by finding similar shapes, redundancy in the shapes of parts of different letters, and a number of dots, dashes, and inverted V were drawn and superimposed on the same basic forms to display different letters. In Figure 27a, a dot, a dash, and an inverted V were superimposed on the same shape, shown in Figure 27b, to form *baa'*, *taa'*, and *thaa'*. This is represented in Figure 27c. In Figures 28 and 29, the letters *9ayn* and *Haa'* use the same lower adjacent parts (007 and 008), but their tops are different. Using the same lower part for both letters reduced the number of graphics. Note that these letters required the use of adjacent dictionary characters.

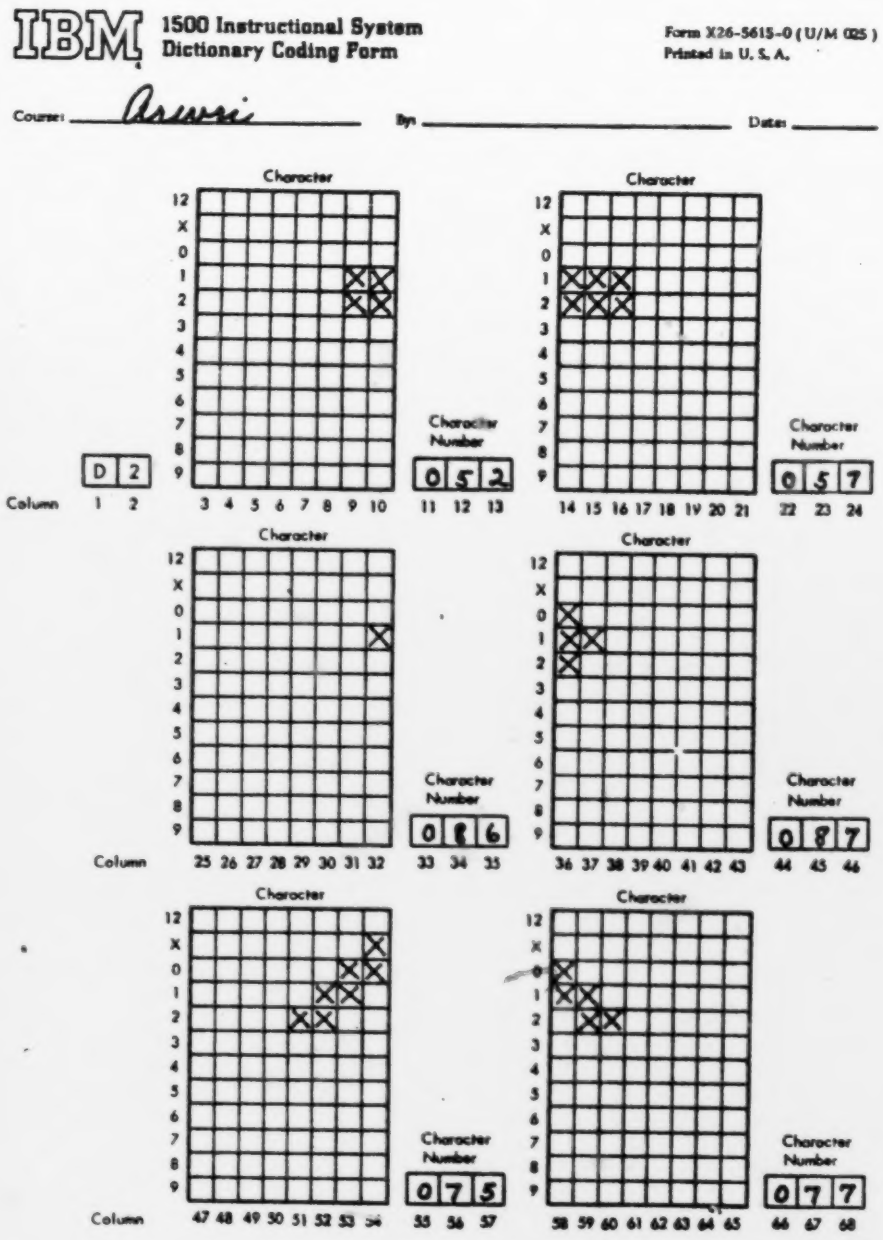


Figure 27a

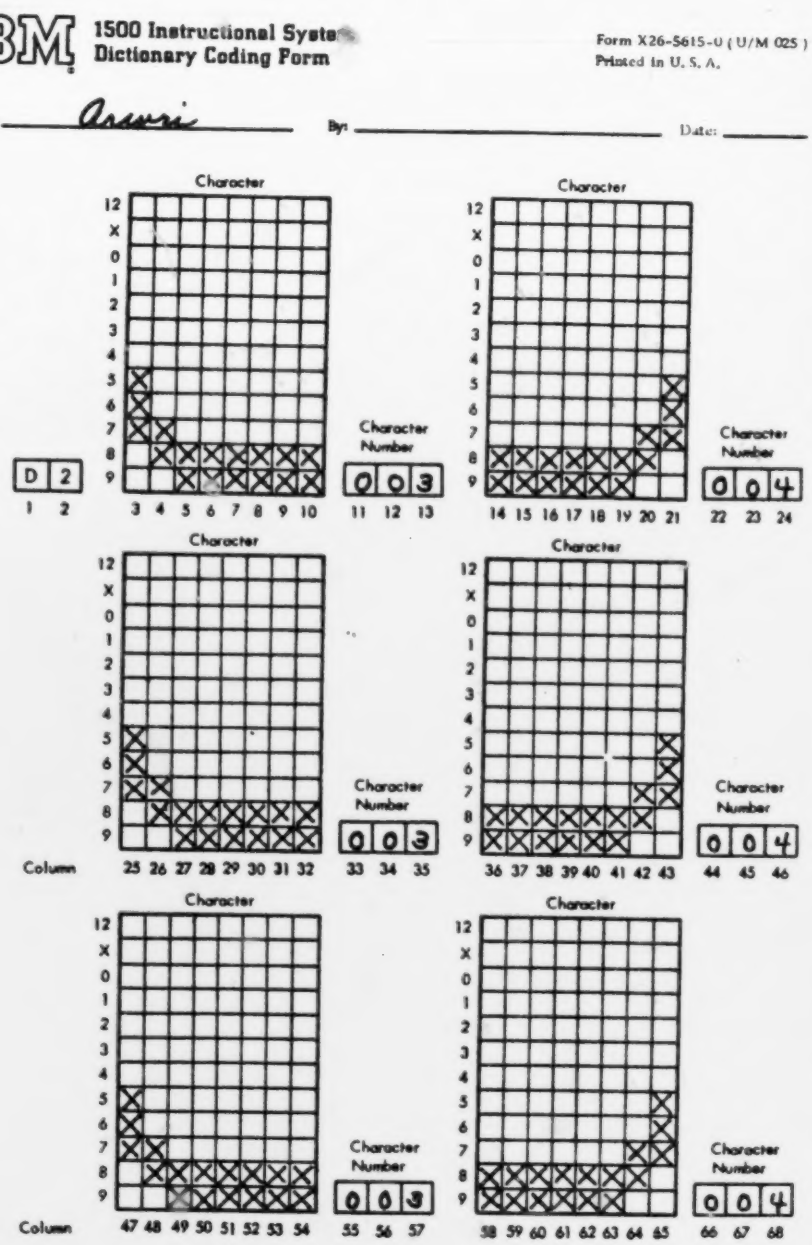
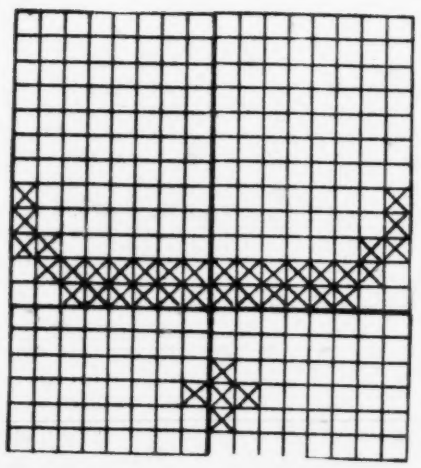
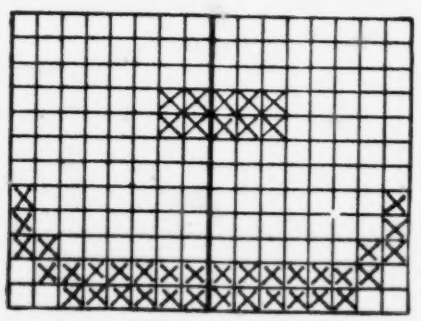


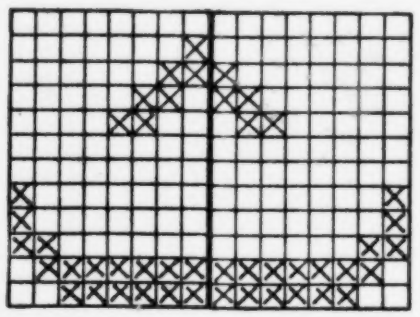
Figure 27b



b



t



th

Figure 27c

IBM 1500 Instructional System
Dictionary Coding Form

Form X26-5615-0 (U/M 025)
Printed in U. S. A.

Courses Assembler By: _____ Date: _____

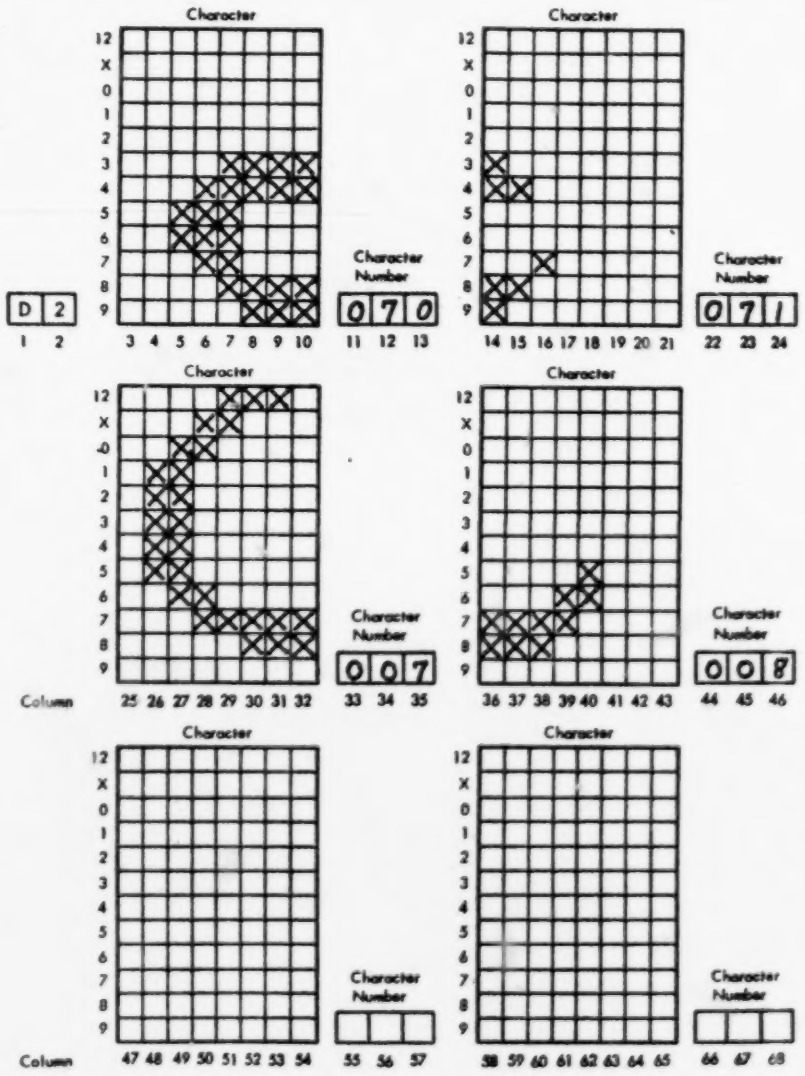


Figure 28

IBM 1500 Instructional System
Dictionary Coding Form

Form X26-5615-0 (U/M 025)
Printed in U. S. A.

Courses Assembler By: _____ Date: _____

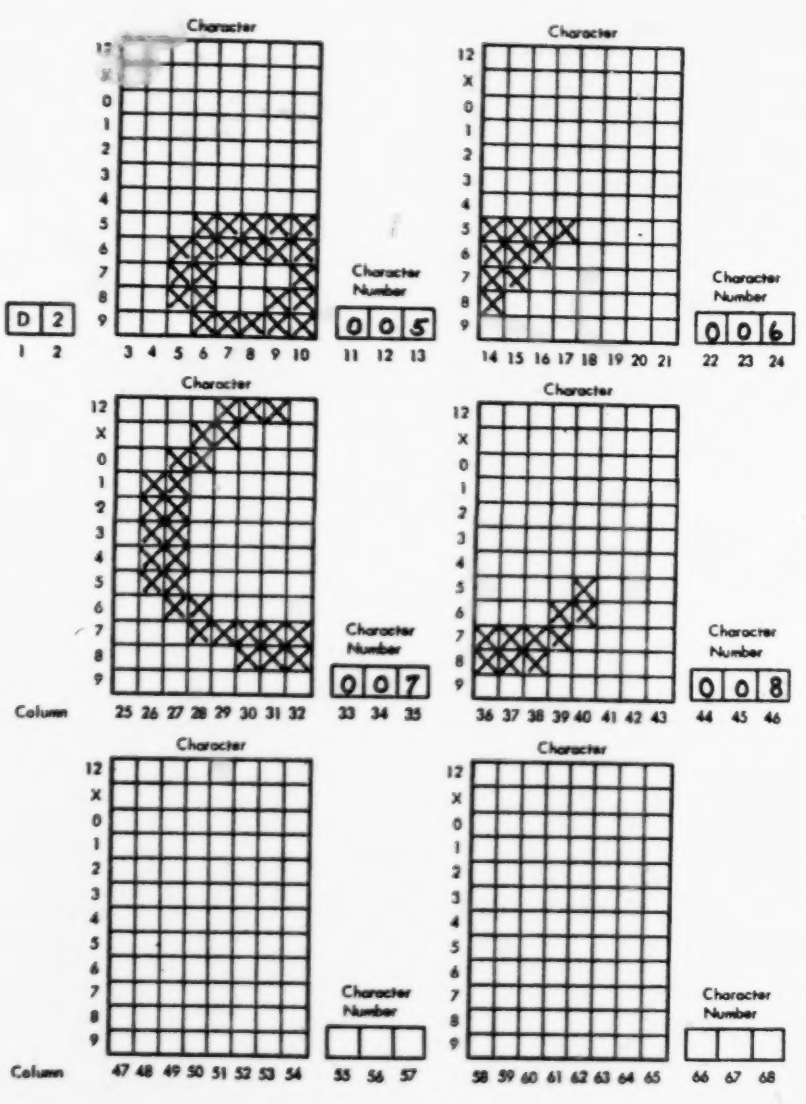


Figure 29

Another important problem that had to be solved was the fact that though all Arabic letters are drawn on or through a line, some of the forms of these letters start above the line, and special conventions in the Arabic writing system dictate whether the letters are to be raised or lowered when joined together. Therefore, a method had to be found to draw such graphics in a way to raise or lower them half a character in size and therefore eliminate the necessity to draw more graphics. This problem applied to dictionary letters and graphic sets. Figure 30a shows how the final form of *miim* starts above the line and how, when *faa'* had to be joined with it, it had to be raised half a character, Figure 30b. Figure 30c also shows that if this is not done, the letters will not join correctly.

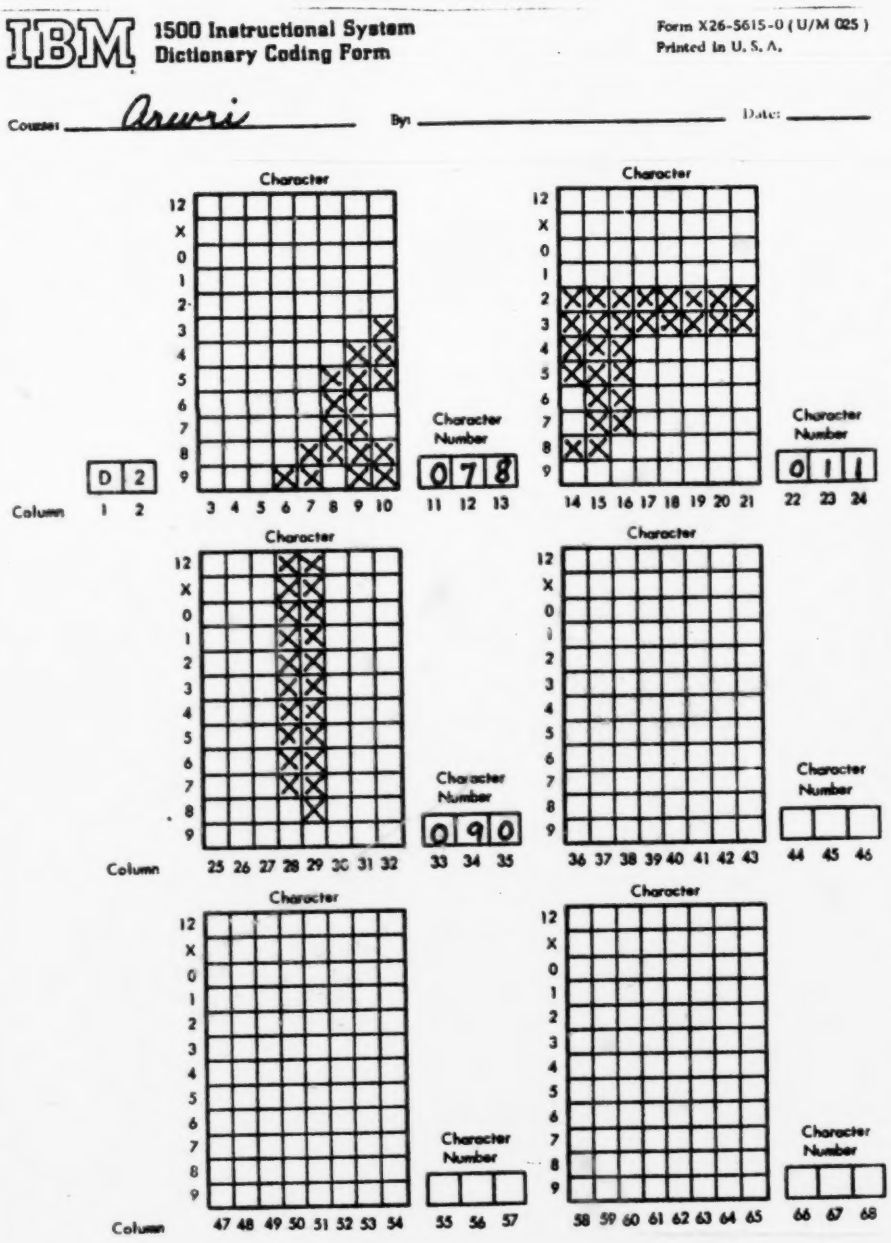


Figure 30a

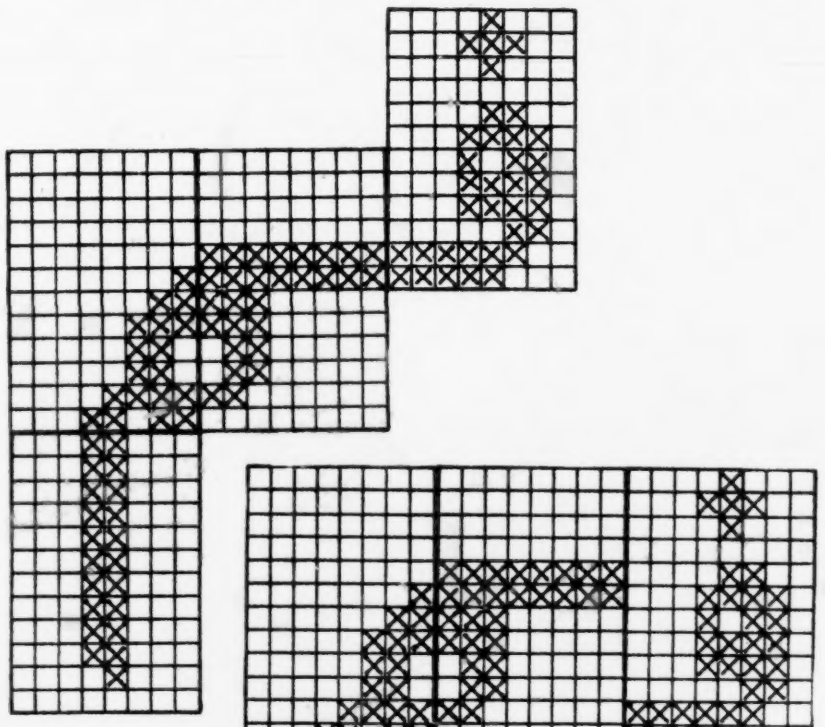


Figure 30b

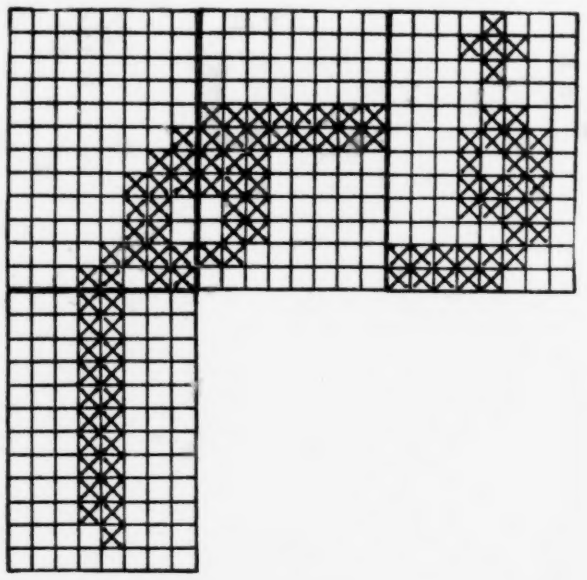


Figure 30c

The 11 diacritics of the Arabic writing system had to be created, too, for both sizes of letters, and sometimes these had to be drawn in many different positions to fit exactly in the position required by the letter with which they were displayed. Arrows, numbers, and many other graphics had to be drawn for this program. A total of 64 graphics (large size of letters) and about 200 dictionary characters (these include all small script as well as diacritics, dots, dashes, and arrows) were drawn.

As Arabic is written from right to left, very exact coding was required. The development of graphic dictionaries and overlay techniques for Arabic script is one of the important contributions of this program, as this may now be standardized and used for a wide variety of computer applications in Arabic.

Summary

In this chapter, a description of all activities needed to produce this CAI program have been described:

(1) The importance of the author's draft for documentation and communication has been demonstrated. The preparation of such a document required the prior steps of course analysis and synthesis of course architecture including the description of the course content, the development of teaching strategies, the careful choice of media, and decisions as to display and response conventions best suited to achieve the goals of this program.

(2) The procedure that had to be taken to implement the author's specifications was also shown. The coding system and the methods by which media specialists prepared their material were introduced.

After viewing what the author, coders, and media specialists had to do in order to get the program ready for use by students, it is not hard to realize the time and effort such a program demands. This is offset by the fact that it may be used to teach many thousands of students.

Evaluation

Introduction. The following describes the principle results of an operational experiment in the teaching of the Arabic writing and sound system. The purpose for such an experiment was to discover the value of instruction by the CAI program reported here in reducing the amount of time taken to complete the course, in improving the ability of the students in the various skills, and in keeping the students interested in their work, thus reducing the possibility of attrition.

Three groups of students of First Year Modern Standard Arabic participated in this experiment in 1970-71. One group of students received

instruction through a programmed instruction course at The University of Michigan at Ann Arbor. This program was written and revised by two professors at the same university and one of the co-authors taught the course. Another group finished the writing and sound system by the audio-lingual method of instruction and the use of a conventional language laboratory at Georgetown University in Washington, D. C. The third group completed the course through a CAI program in conjunction with classroom instruction at The University of Texas at Austin.

A comparison of the results of the total grades taken by students at the completion of the CAI program at UT during 1970-71 and those of the programmed instruction course taught at UT during 1969-70 was also found to be very useful in assessing the value of the CAI program, as conditions for both these groups were very similar and students were taught by the same professor and the same assistant to the professor.

Methods of Instruction: The University of Texas at Austin. During the academic year 1969-70, the writing and sound system of Arabic was taught through a programmed instruction course. There were two sections of 14 students each registered in first-year Arabic. The students were provided with workbooks which gave the description of the various sounds, instructions in writing, reading, and various other drills. The class was conducted in the Language Lab., where each student occupied an individual booth but all had to follow a master tape; thus, it was a *lock-step system.* An instructor was always present, and, when necessary, he stopped the master tape to clarify a point, describe the formation of a sound, or give supplementary drills for difficult sounds or sound sequences. The student could record the lessons on tape and was then able to replay it. The students spent about six hours a week in the Laboratory, and about five weeks were required to complete the course. Students seemed to find this period too long and tedious and were soon impatient to start on meaningful utterances. There was an attrition of four students, or 14% of the entire class.

In the academic year 1970-71, the CAI program was adopted by the professor responsible for the Arabic program at UT. The course was taken by 32 students, who were divided into two sections. In the first class period, the professor gave an overall view of the course, First Year Modern Standard Arabic, and told the students that the writing and sound systems would be taught by computer in conjunction with classroom instruction. The students were given a tour of the CAI Lab, as well as a short demonstration to acquaint them with the capabilities of the IBM 1500 terminals. During the first week, only four terminals (with audio units) were available; during the second week, the students were able to use six terminals and were allowed to use the terminals one hour a day (many were willing to come early in the morning or late in the afternoon). Proctors were always available to help with any mechanical problems. In the CAI Laboratory, each student proceeded at his own pace, working on only one of the four cycles at a time and going on to the next cycle only when he had succeeded in all tests of the previous

cycle. Each section (16 students each) met with the professor for two 50-min. periods a week. These classroom hours were devoted only to drilling of the sounds which the students had already heard on tape at the computer terminal. Students found this very useful, as they could then see the professor pronounce the sounds and thus could observe the point of articulation and the manner in which the sound is produced. The students taking the CAI program were able to complete the course satisfactorily by spending a total of four to eight hours at the computer terminal, and four hours of sound drills, reading, and dictation in the classroom. There was no classtime devoted to instruction for writing; this was accomplished totally by the CAI program. Students showed great enthusiasm for the course, and, because of their rapid progress, the slump which usually occurred during previous years due to the amount of time it took to learn merely how to write and to pronounce the various letters of the alphabet did not occur. There was no attrition, and the students progressed rapidly during the rest of the semester and received high grades in their final exam.

During the CAI program, no students dropped the course. Out of these 32 students, two dropped the course for administrative reasons. However, the 30 students remaining enrolled kept their enthusiasm for Arabic and completed the course in the first semester.

Methods of Instruction: The University of Michigan. The Arabic writing and sound system was presented through a revised programmed instruction course at The University of Michigan. The professor in charge of this program, Dr. R. Rammuny, met with the students for two hours in which the nature of the course was discussed and instructions were given to the students as to the procedures to be taken.

The students had individual booths at the Laboratory which contained earphones, tape, and tape recorders, and students were able to record and listen to their own recording, comparing it with the model. Workbooks were used which gave all the explanations and instructions for writing and sound drills. The students were asked to trace the letters taught and asked to practice them in their workbooks. The students required 22-30 hours in the Laboratory to complete the course. There were 21 students registered in the course, but two of them did not complete it; that is, there was an attrition of about 10%.

Methods of Instruction: Georgetown University. At Georgetown University, where Dr. Wallace Erwin is the professor responsible for the Arabic program, the Arabic writing and sound system was taught in the classroom by the audio-lingual method and was supplemented by drills in a conventional language lab. The book used for instruction was *Elementary Modern Standard Arabic*, and all drills for writing, sound discrimination and dictation were taken from the early chapters of the textbook. In the language lab, each student sat at an individual booth and was able to have the drills in the book and supplementary drills on tape. The student could operate his own console and thus could control the speed and amount of material presented. The students required about 14 50-min. periods of classroom instruction, and 12-15 hours in the laboratory. There were 19 students registered in the course and all were able to complete it. There was no attrition.

Testing Procedure. In the summer of 1969, the author of the CAI program met in Ann Arbor, Michigan, with Dr. R. Rammuny from The University of Michigan and Dr. P. Abboud from The University of Texas at Austin, to discuss the possibility of conducting an experiment for the purpose of comparison in terms of achievement in the writing and sound system and in terms of the time necessary to complete the course. The two professors agreed as to the skills to be tested. These were to include the ability to write the cursive form, to read the cursive and printed form, to discriminate sounds, and to take down a few words as dictation.

At a later date, the author contacted Dr. Wallace Erwin, the professor responsible for the Arabic program at Georgetown University, and asked him whether he would be willing to participate in such an experiment. He kindly agreed and approved the content of the final test.

The experiment was prepared as a comparative evaluation study rather than as a fully-controlled experimental test of the effects of specific CAI variables vs. classroom variables. Some of the differences between the three groups were as follows: method of instruction, time in which the program was completed, the effect of novelty on achievement, and teacher differences. These complex variables make a simple comparison of the results difficult to interpret. However, the three universities used the same basic materials in the textbook *Elementary Modern Standard Arabic* prepared by a group of professors of Arabic, and the three professors responsible for the course were among the authors of that textbook.

The final test for the Arabic writing and sound system was prepared with the specifications approved by the three professors. It was sent to the participating universities to be given to the students upon completion of instruction in the writing and sound system of Arabic. The test consisted of three parts: (1) testing writing skill, (2) giving words as dictation, and (3) testing sound discrimination (when students had to choose the correct form of the word which was read from five words given in each example).

Explicit instructions were given as to the latency between items read either for sound discrimination or dictation. The number of minutes to be devoted for the writing exercises was given, and the number of points to be given for each correct answer was specified. The test was administered and corrected in each of the three universities by the professors responsible for the course.

Three scores were given--one for writing skills, another for sound discrimination, and the third for total grade, which included the other subtests plus items of dictation. Discrepancies in the administration of the dictation portion of the test were reported due to differences in the interpretation of instructions as to the number of repetitions of the items of the dictation. Thus, the dictation score was not analyzed and does not appear in Table 4.

Results. Table 3 represents the number of hours taken by the students in the different groups to complete the course in the writing and sound system of Arabic. The group of students at The University of Texas at Austin (UT) taking the CAI program finished the course in eight to twelve hours, which is only 40% of the time taken by the other groups, including the UT students who had taken the course through programmed instruction in 1969. This result is significant as the degree of interest and motivation of the students was easily maintained for such a short time, and the students were able to begin learning meaningful utterances and basic rules of grammar much earlier in the year. Results of the statistical analyses of the scores taken by the three participating universities are reported in Tables 4, 5, and 6.

For *writing skills*, UT students learning the course through the CAI program had a much higher mean than the other two universities. The standard deviation for the CAI group was also much smaller, indicating that most of the students received scores very close to the mean. The CAI group had a higher minimum score than the non-CAI group. Thus, learning gains were larger for the slower students, and the lower part of the class was able to reach up to the level of the students at the top.

For *sound discrimination* and *total grades*, the means for the CAI group were slightly higher than for the non-CAI groups; that is, UT students achieved an equal standard of proficiency as the other universities.

Table 5 shows the descriptive analysis for the total grades received by UT students taking the CAI program in 1970 and those received by programmed instruction in 1969. The results show that here, too, the CAI group had a higher mean than the non-CAI group. The result was statistically significant ($p < .005$).

Table 6 is the source table for the analyses of variance of the scores for writing skills, sound discrimination, and total grades for the three participating universities. The CAI group at UT obtained better results than the other two groups in writing and total grades ($p < .001$). For sound discrimination, although the mean for the CAI group at UT was slightly higher, the results did not have statistical significance.

Table 3

	UM*	UT (69-70)	UT (70-71)*	GU*
Classroom Instruction	---	---	4	14
Laboratory	22-30	24-30	4-8	12-16
Total	22-30	24-30	8-12	26-30

*GU represents Georgetown University, Washington, D. C.
UM represents University of Michigan, Ann Arbor, Michigan.
UT represents University of Texas, Austin, Texas.

Table 4

Descriptive Statistics of Sample Groups

School	*n*	Mean	Standard Deviation	Minimum	Range
			Writing		
Georgetown	19	68.16	24.23	15	85
U. of Texas (70)	32	91.47	7.75	70	29
U. of Michigan	19	79.32	20.03	20	80
			Sound Discrimination		
Georgetown	19	77.00	13.18	45	50
U. of Texas (70)	32	83.94	10.96	65	35
U. of Michigan	19	82.63	11.95	60	40
			Total Scores		
Georgetown	19	67.68	16.99	38	51
U. of Texas (70)	32	82.03	11.77	58	41
U. of Michigan	19	80.79	13.59	48	50

Table 5

Comparison of Total Scores at The University of Texas

Year	*n*	Mean	Standard Deviation	Minimum	Range
1969	24	70.08	15.82	37	60
1970	32	82.03	11.77	58	41

$t = 3.05$
$p < .005$

Table 6

Analysis of Variance for the Three Universities

Source	Mean Square	*df*	*F* Ratio
	Writing Score		
Between Groups	3322.3	2	
Within Groups	293.2	67	11.33**
Total	17.1	69	
	Sound Discrimination Scores		
Between Groups	298.2	2	
Within Groups	140.6	67	2.12
Total	11.9	69	
	Total Scores		
Between Groups	1343.5	2	
Within Groups	191.2	67	7.03**
Total	13.8	69	

**$p < .01$

Student Evaluation of the CAI Program for the Arabic Writing and Sound System at The University of Texas at Austin, 1970-71. Upon completion of the CAI program at UT, the students received a questionnaire before the final test and were asked to answer the questions frankly. The questionnaire was in two parts: (1) one was for the purpose of evaluating the CAI program itself, and (2) the other was for student reactions to the capabilities of the computer terminals and their effect on the learning process. Table 7 shows the list of questions given to 32 students about the program and its content. Their answers were graded from 0 to 3.

Table 7

Results of Student Questionnaire Regarding Program and Content

Questionnaire Items	Mean	SD	Scale†						
			0	0.5	1	1.5	2	2.5	3
1. Enjoyed it.	2.42	.61						X	
2. Too impersonal.	.62	.74		X					
3. Speeds up learning	2.50	.84						X	
4. Too complicated.	.29	.46	X						
5. Interesting.	2.42	.62						X	
6. Too mechanical.	.61	.67		X					
7. Responsive to individual needs.	2.00	.68					X		
8. Program "controlled" me too much.	.93	.85			X				
9. Needed more help from proctors:									
(A) at first	1.23	.61				X			
(B) after first hour	.66	.59		X					
10. Felt "computer" was friendly.	1.74	.77					X		
11. ... stern	1.67	.82				X			
12. ... courteous	2.00	.73					X		
13. ... demanding	1.39	.96				X			
14. ... flexible	1.47	.72				X			
15. ... stimulating	2.00	.88					X		
16. ... pushy	.90	.70			X				
17. ... repetitious	1.30	.80				X			
18. ... dynamic	1.66	.78					X		
19. ... frustrating	.79	.65		X					
20. ... boring	.80	.73		X					
21. ... helpful	2.63	.98							

† 0 = Not at all; 1 = Not much; 2 = A lot; 3 = Very mucn.

The tabulations of the results show that a high grade was given for the positive factor. The students enjoyed the program, found that it speeded up learning and that it was interesting, responded to individual needs, and was courteous and helpful. It also shows that the students did *not* find the program too complicated, impersonal, mechanical, nor that it controlled them too much, was "pushy," or repetitious.

Table 8, presented below, shows the tabulation of the results of the questionnaire regarding the capabilities of the computer terminals. As can be noted, the use of the felt pen and colored slides were not felt to be of great importance for the successful achievement of the CAI program. All other aspects of the program were found to be very useful. The author of this CAI program believes that for students to successfully pronounce the sounds which are new and foreign, a dynamic model must be given. Some computers which will soon be on the market will provide such a model, and then the need for classroom drills will be greatly diminished.

Table 8

Evaluation of the CAI Terminal

Questionnaire Items	Mean	SD	Scale†						
			0	0.5	1	1.5	2	2.5	3
22. Immediate feedback.	2.63	.80						X	
23. Colored slides.	1.30	.80				X			
24. Use of felt pens.	1.06	1.06			X				
25. Option to repeat practice items.	2.52	.57						X	
26. Audio.	2.58	.72						X	
27. Classroom drills in sounds.	2.90	.57							X
28. Use of 4 cycles of letters.	2.57	.49						X	
29. Cursive letters on CRT, printed on film.	2.25	.58						X	
30. Tests given on computer.	2.61	.76						X	
31. Use of lightpen.	2.42	.63						X	

† 0 = Not at all; 1 = not much; 2 = A lot; 3 = Very much.

Evaluation of the Appeal of the Program without Grade Incentive. The highly favorable response of the CAI students at The University of Texas at Austin prompted another study. It is claimed by many that the initial stages of language learning are boring and tedious, yet these students expressed great enthusiasm for the CAI program. We wished to find out how hard students would work and how many would complete the program with no credit or grade attached as an incentive.

To investigate this, an advertisement was placed in the student newspaper offering to provide free computer time for those wishing to learn the Arabic writing and sound system. A total of 33 students and staff signed up, but only 30 took any part of the program. Due to heavy use and some breakdowns of the system, many students encountered difficulties in operation and scheduling. The Christmas holidays interrupted the work of several before completion. Despite this, 20 were able to complete the program and found it very interesting.

One incident occurred that has never happened before at UT. One of these 20 volunteers became so interested in Arabic that she requested an opportunity to register for the second semester of first-year Modern Standard Arabic, and she was admitted on probation. The professor observed that her writing was very good, and, because she had learned the sound system too, she was able to catch-up with the other students. She worked hard to cover the material the class had completed in the first semester. On the first test, she passed successfully and will be able to complete the course with the rest of the class.

The results of this study with volunteers can be viewed as evidence that language instruction, especially in its initial stages, can be more appealing, interesting, and enjoyable. Contrary to the hypercritical view of the archhumanist that anything associated with computers must by definition be sterile, rigid, and inhumane, it is seen that tastefully-designed CAI can be a most profitable and useful tool for the serious student. Indeed, bright and motivated students can "leapfrog" a great deal of tedious classroom work through the use of programs like this one.

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This document was prepared by
Joy Bohmfalk
Publication Editor and Producer
Computer-Assisted Instruction Laboratory
The University of Texas at Austin